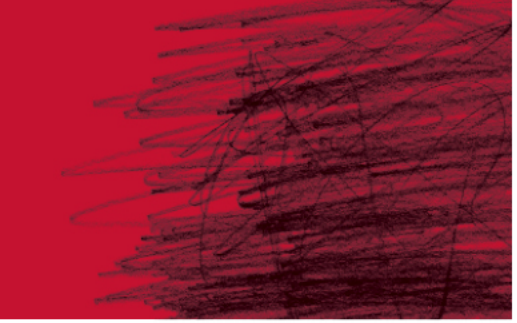


LEARNING ENGINEERING ECOSYSTEM

OPEN SOURCE

OPEN SOURCE LEARNING

HACKATHON

Evidence-based Courseware Improvement with OpenSimon Analytics

Norman Bier

EXECUTIVE DIRECTOR, THE SIMON INITIATIVE
DIRECTOR, OPEN LEARNING INITIATIVE

Erin Czerwinski

PRODUCT and COMMUNITY MANAGER, THE SIMON INITIATIVE

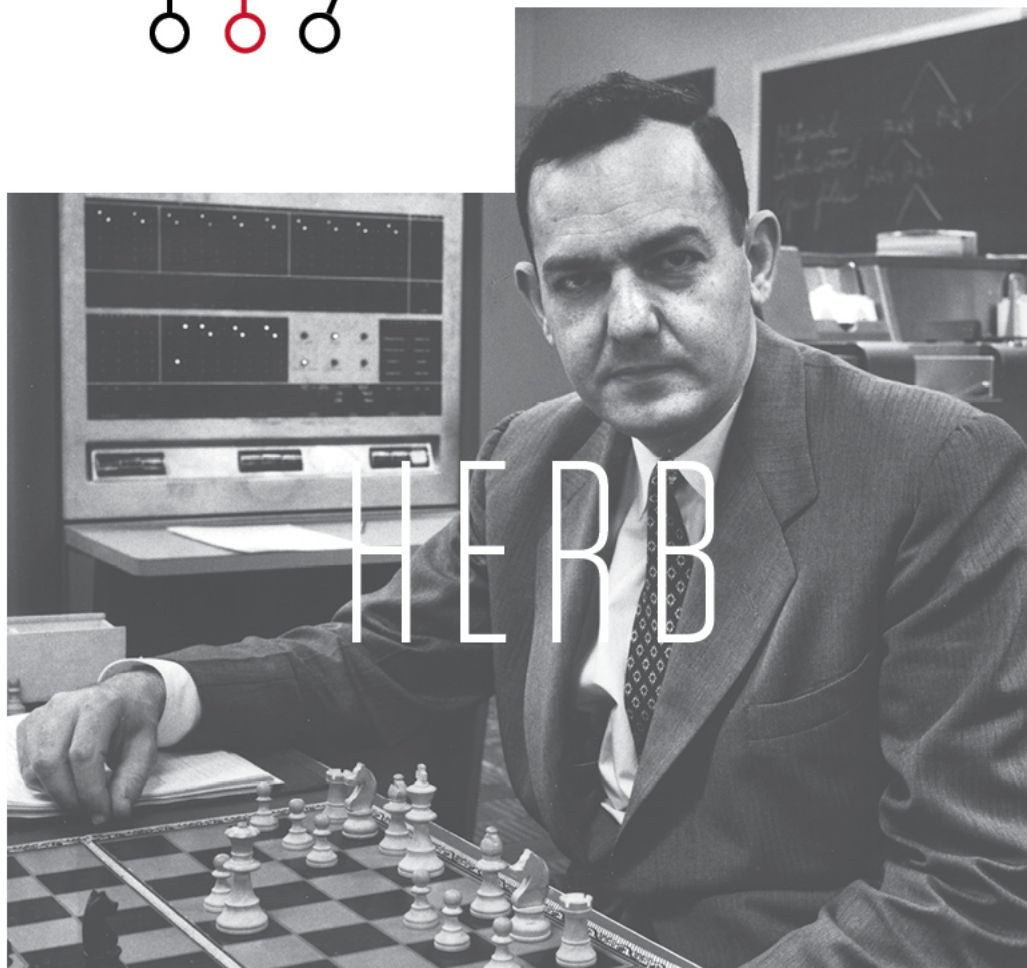
Candace Thille

ASSOCIATE PROFESSOR of EDUCATION, STANFORD UNIVERSITY
DIRECTOR of LEARNING SCIENCE and ENGINEERING, AMAZON

Carnegie Mellon University
The Simon Initiative

“Improvement in post-secondary education will require converting teaching from a solo sport to a community-based research activity.”

DATA EMPOWERED LEARNING



How do we design and improve learning?

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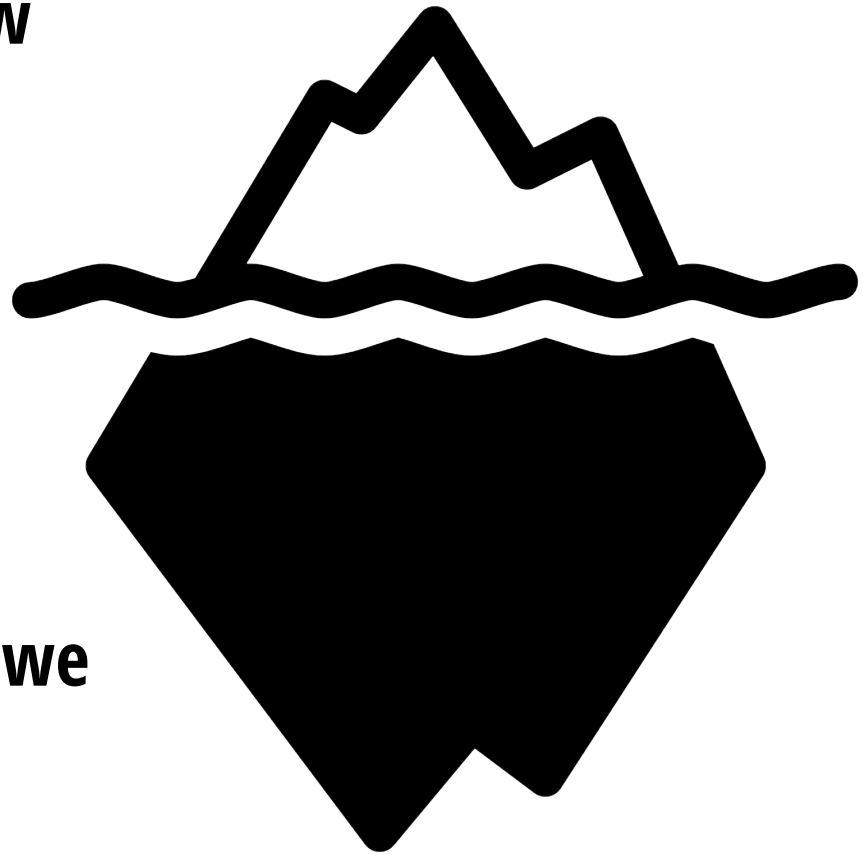
The Simon Initiative

Intuition-based design *lacks information*

What we know about our own learning



Experts can describe only 30% of what they know!

What we do not know we know

Data breaks illusions

Making learning something you can observe

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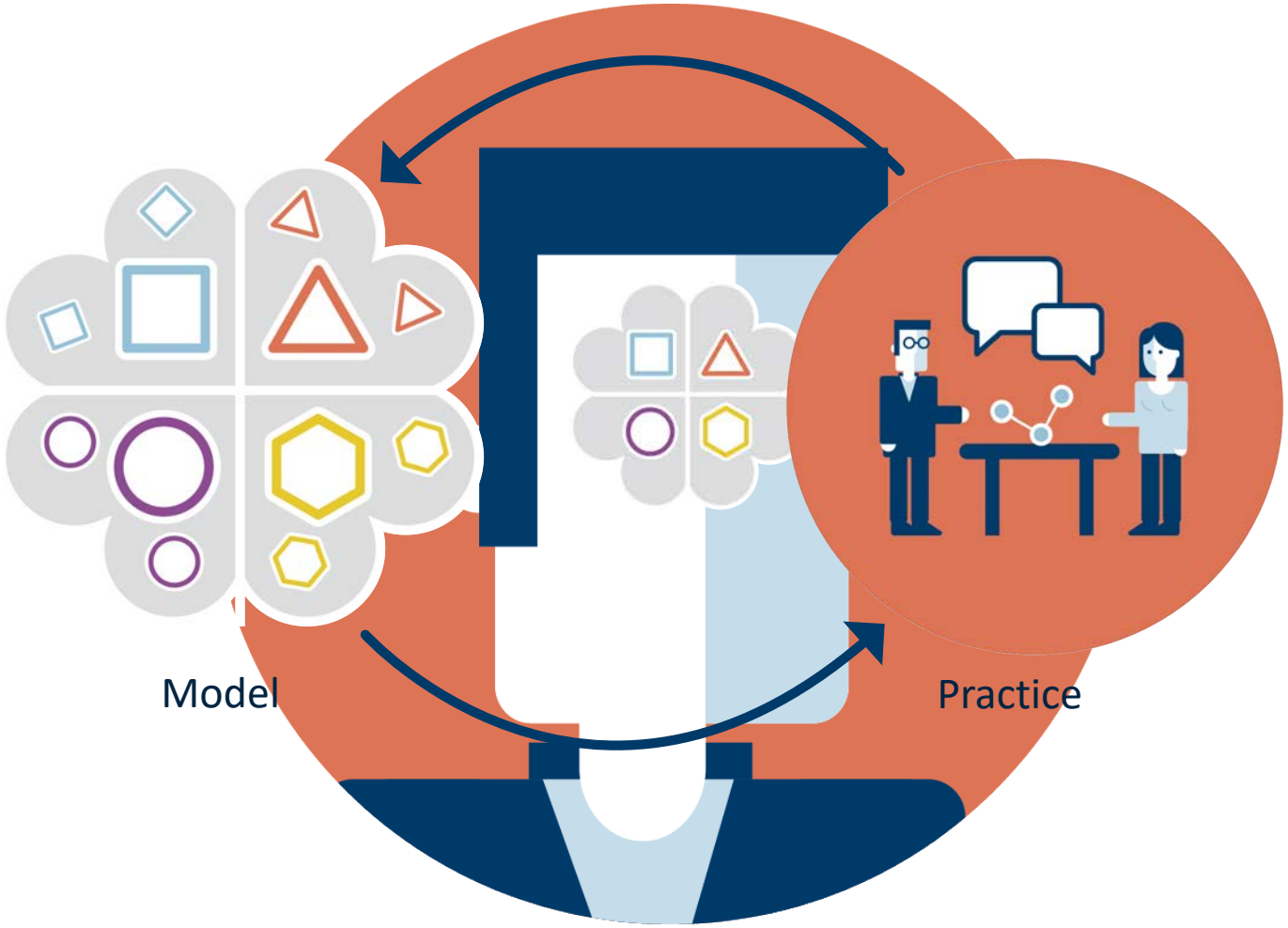
The Simon Initiative

Making learning something you can observe



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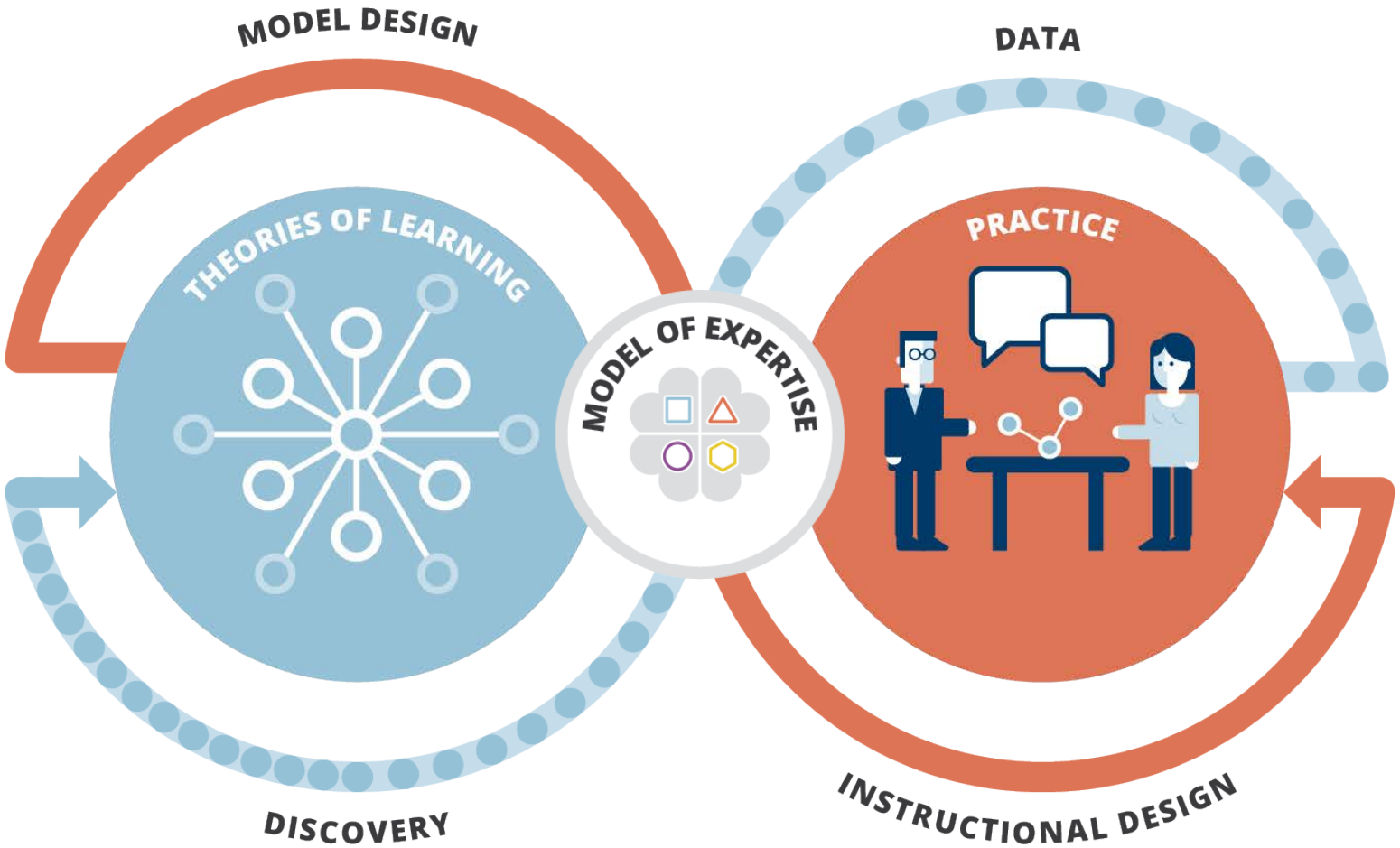
The Simon Approach: Learning Engineering



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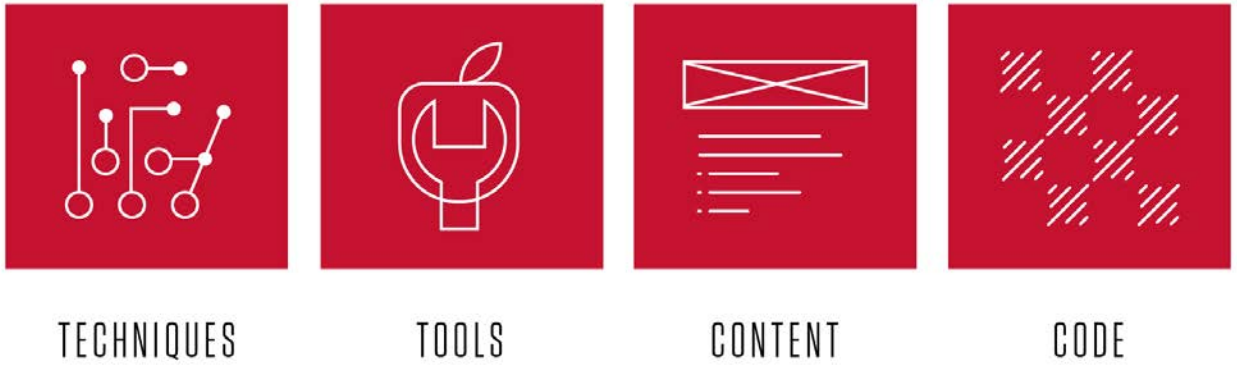
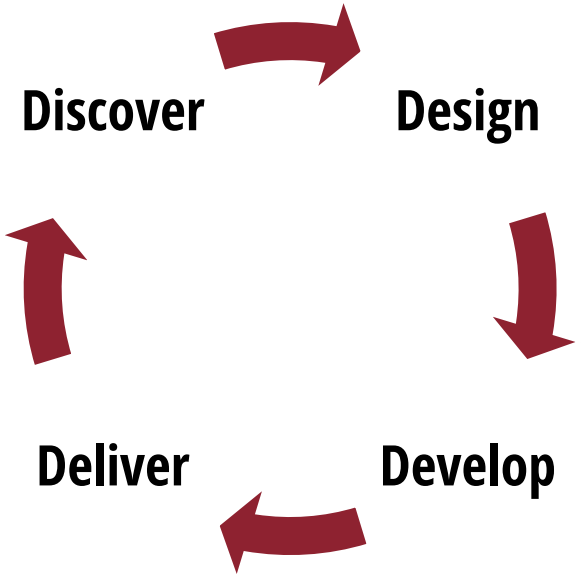
OpenSimon Toolkit





to support *applying* learning engineering to the life cycle of educational projects

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The Simon Initiative

From tools…

ChemCollective

DANCE
Discourse Affordances for Natural Collaborative Exchange

The Tetrad Project

Open Learning Initiative
Carnegie Mellon University

Pittsburgh Science of Learning Center
DataShop

ROBO TUTOR

LearnSphere

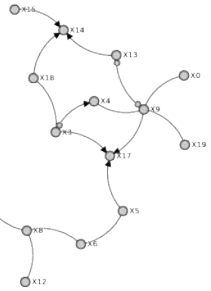
CTAT
CognitiveTutorAuthoringTools

Bazaar

DiscourseDB

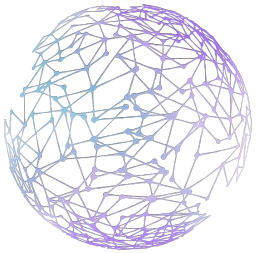
Carnegie Mellon University
The Simon Initiative

...to ecosystem



The Tetrad Project

Your Tools and Approaches



LearnSphere

INTEGRATION + INTEROPERABILITY BACKBONE

CTAT

CognitiveTutorAuthoringTools

DANCE

Discourse Affordances for Natural Collaborative Exchange

Open Learning Initiative

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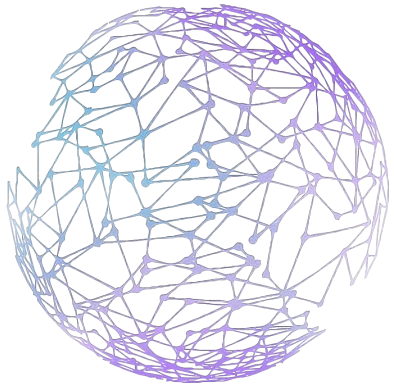
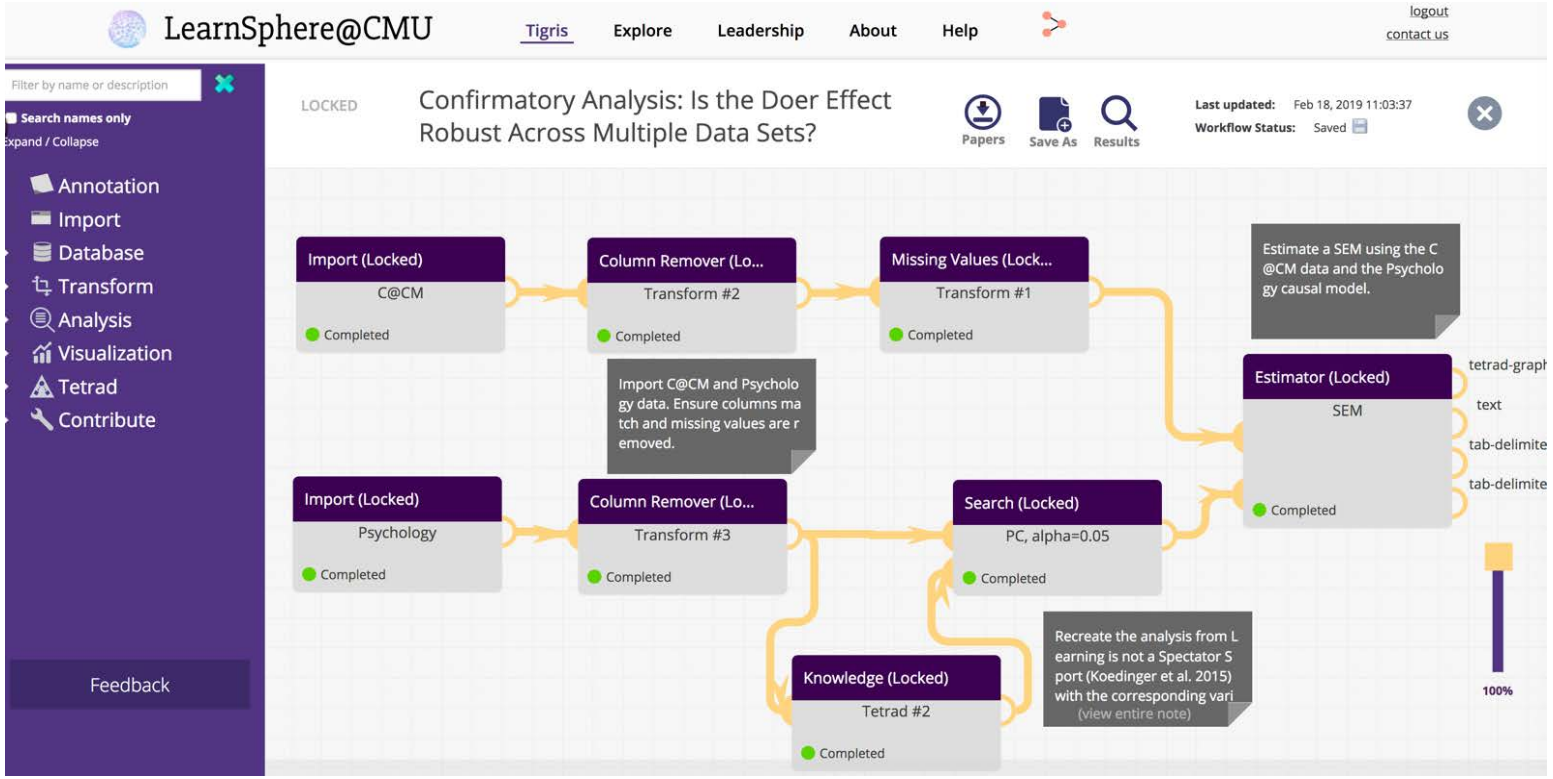


LearnSphere

Open Learning Initiative

Carnegie Mellon University

LearnSphere



- Shared educational datasets and analytic methods
- Workflow tools:
  - Data transformation
  - Analysis
  - Visualization
- Causal Modeling

http://learnsphere.org

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Open Learning Initiative

Transforming higher education through the science of learning.

Scientifically-based, open, online-learning environments based on the integration of technology, the science of learning and teaching.

OLI is designed to simultaneously improve learning and facilitate learning research.

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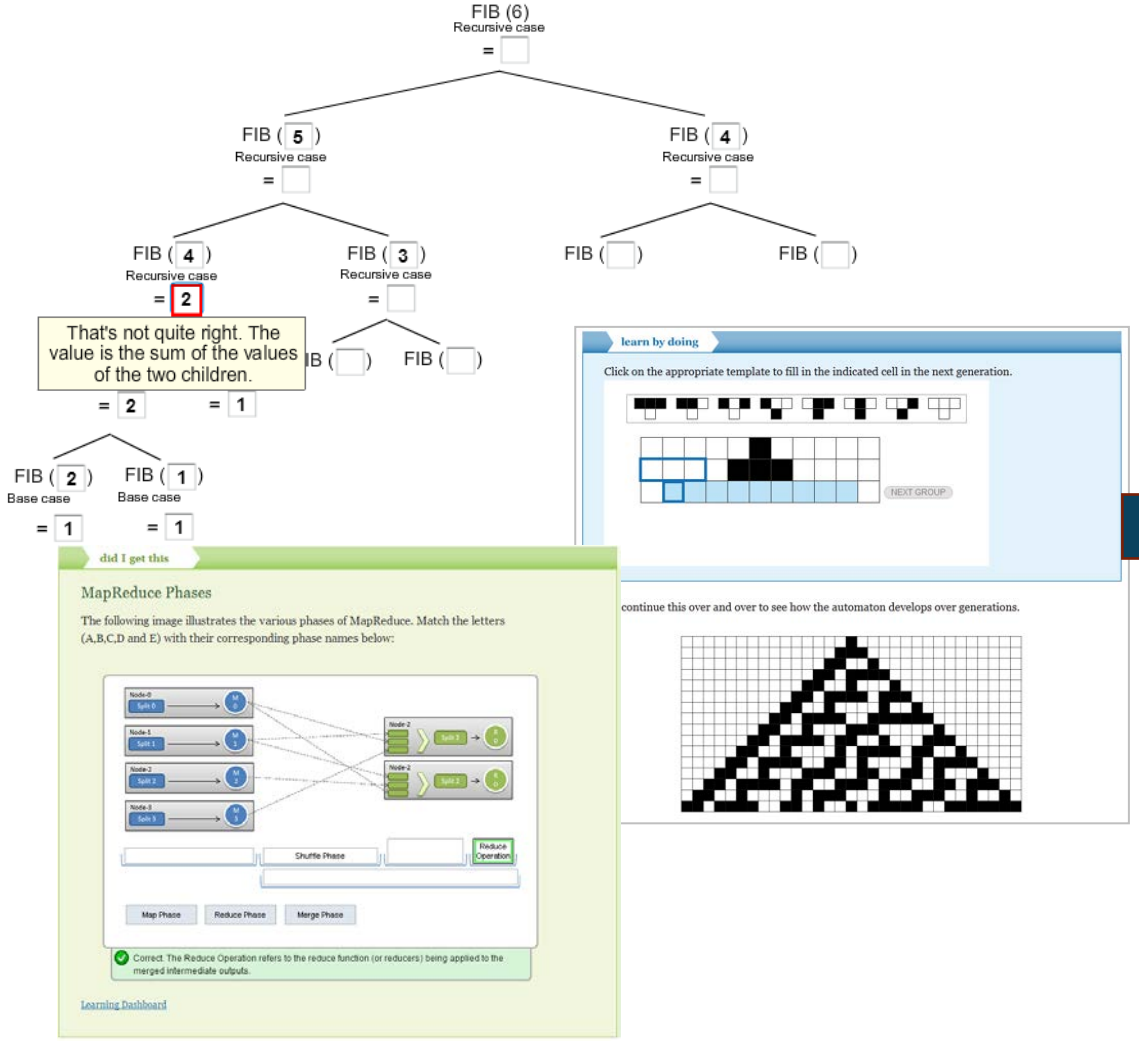
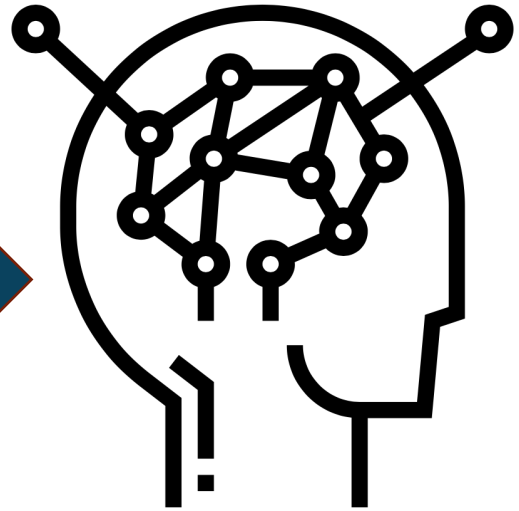
Learning design as hypothesis





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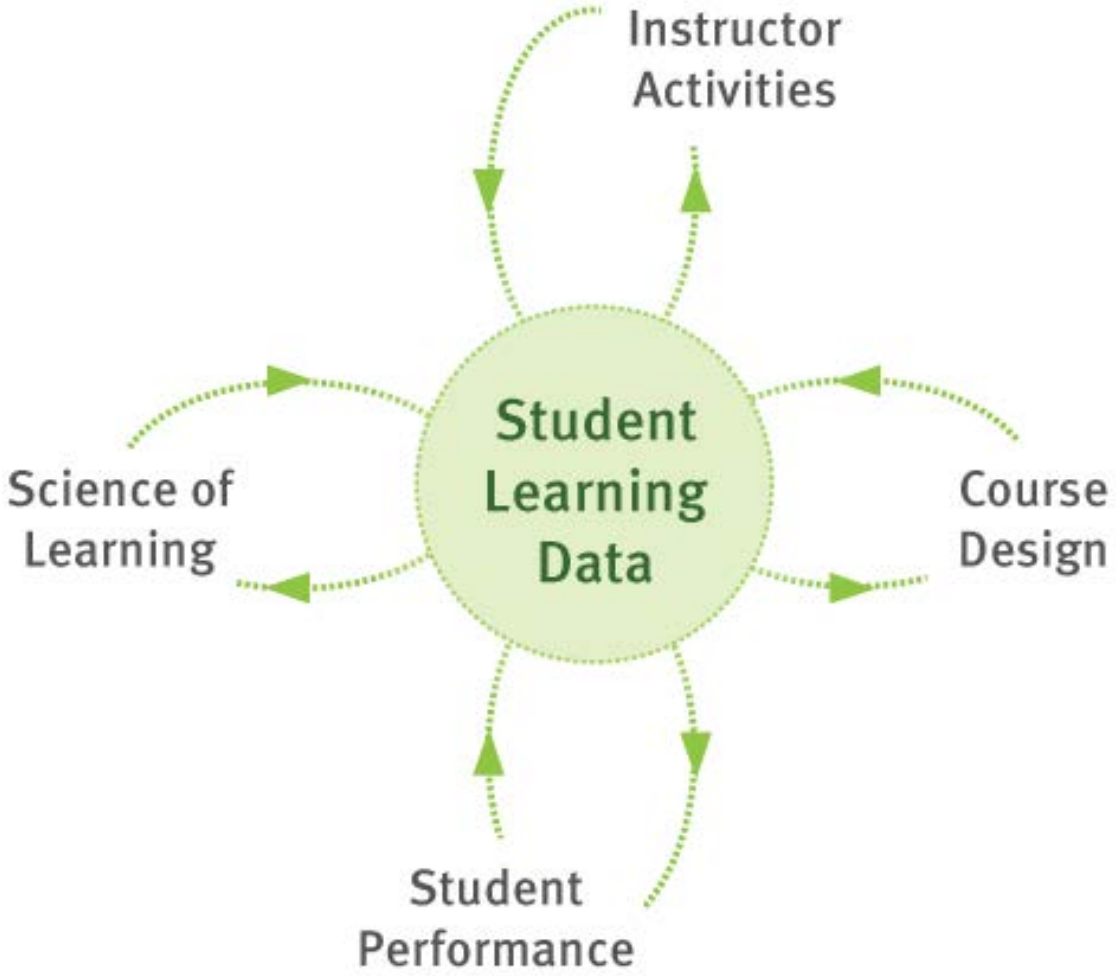
Data drives powerful Feedback Loops



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Instrumented

- Data Collection
- NOT Click Stream
- Learner Interactions
- Semantic Context
- Implies Design

What are potential sources of data?

- The course itself
- Learner performance
- Learner usage
- Learner feedback
- Instructor feedback

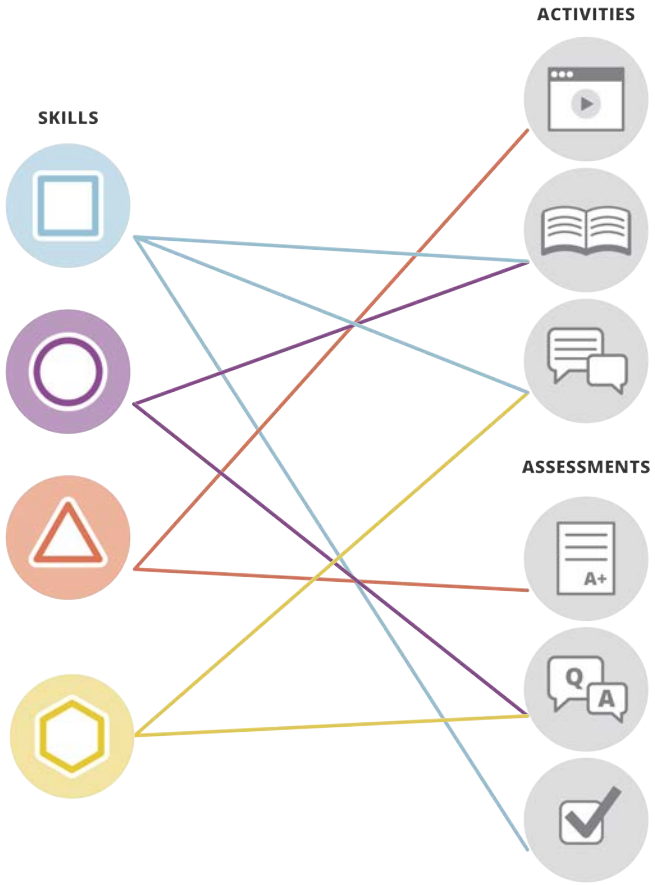
What are potential sources of data?

- The course itself
- Learner performance
- Learner usage
- Learner feedback
- Instructor feedback

Data and Analytics

Types of Data	Types of Analytics
Structural	**Design Audit**

Model



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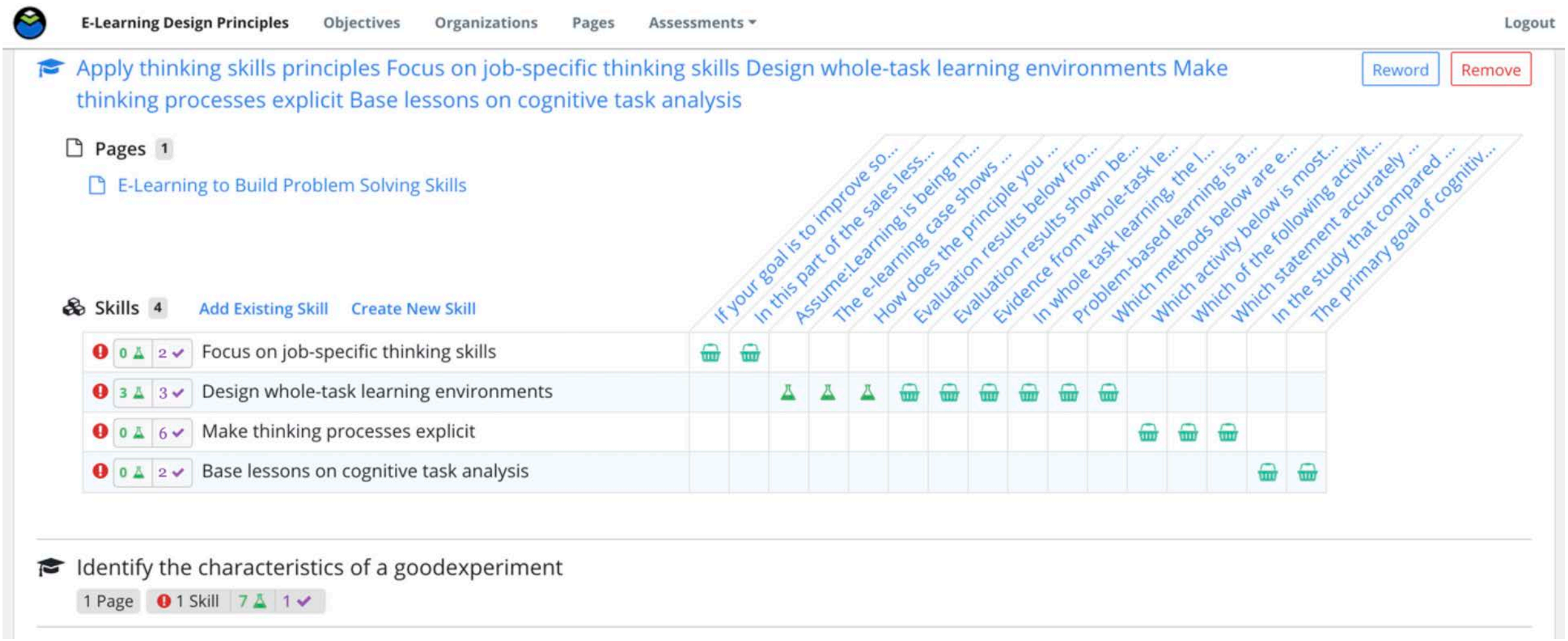
Structural data

- Content
- Practice Opportunities
- Assessment Opportunities

- What is my model?
- Does it reflect best practices?
- Is my hypothesis complete enough for testing?

Design Audit



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This was all before students worked with your course materials…

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Data and Analytics

Types of Data	Types of Analytics
Structural	Design Audit
Use and Assessment	RISE

RISE:

Resource
Inspection
Selection
Enhancement

lumen

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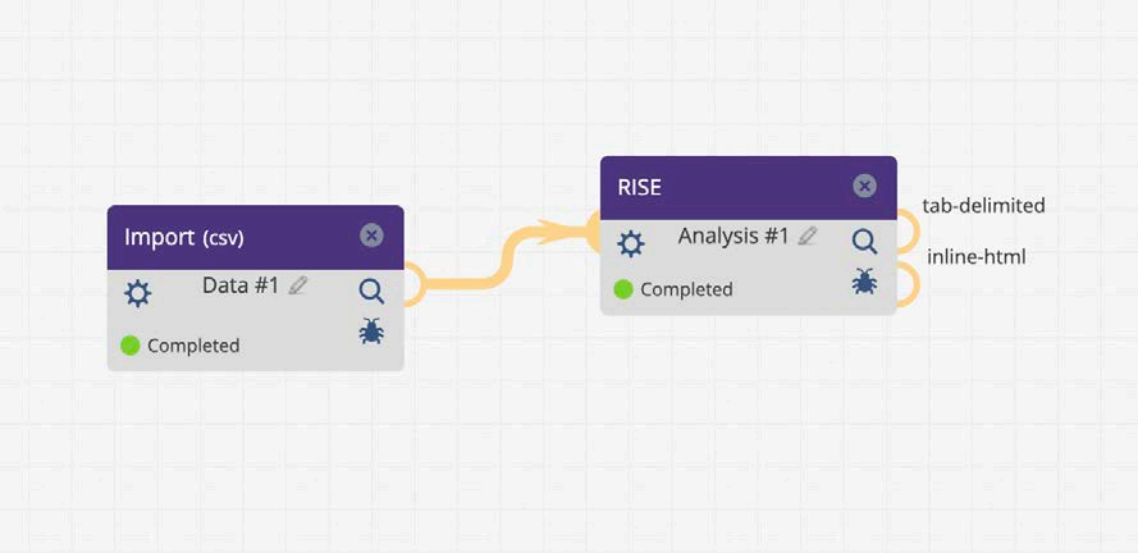
LearnSphere Component

Inputs and workflow

	A	B	C
1	skill_id	Use/Practice	High Stakes
2	_u01_m01_i	0.916667	0
3	_u01_m01_s	1	0
4	_u01_m01_s	0.710909	0
5	_u02_m01_b	0.62	0
6	_u02_m01_r	0.96	0
7	_u02_m01_r	0.593333	0
8	_u02_m01_p	0.886667	0
9	_u02_m01_p	0.796452	0.8
10	_u02_m01_p	0.39	0
11	_u02_m01_p	0.634118	0.896667
12	_u02_m01_p	0.555714	0.89
13	_u02_m01_p	0.558571	0.888571
14	_u02_m01_c	0.915	0.38
15	_u02_m01_c	0.87	0.9725
16	_u02_m01_c	0.662857	0.38
17	_u02_m01_c	0.80375	0.728
18	_u02_m02_b	0.791667	0
19	_u02_m02_c	0.6475	0.835
20	_u02_m02_c	0.868571	0.88
21	_u02_m02_c	0.689	0.835
22	_u02_m02_c	0.824444	0.808889
23	_u02_m02_p	0.93	0.46
24	_u02_m02_p	0.876	0.685
25	u02_m02_p	0.485	0

Demonstration



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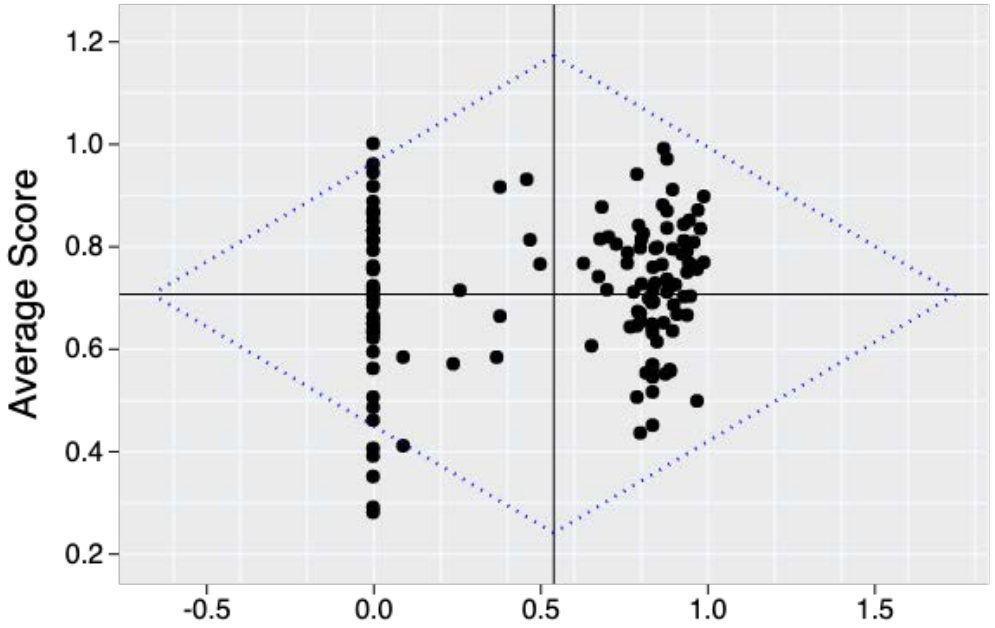
Outputs and Analysis



High

Learning

Low

- High student prior knowledge
- Inherently easy learning outcome
- Highly effective content
- Poorly written assessment

- Effective resources
- Effective assessment
- Strong outcome alignment

- Low student motivation
- High life distraction
- Too much material
- Difficulty accessing resources

- Poorly designed resources
- Poorly written assessments
- Poor outcome alignment
- Difficult learning outcome

Low Content Use *High*

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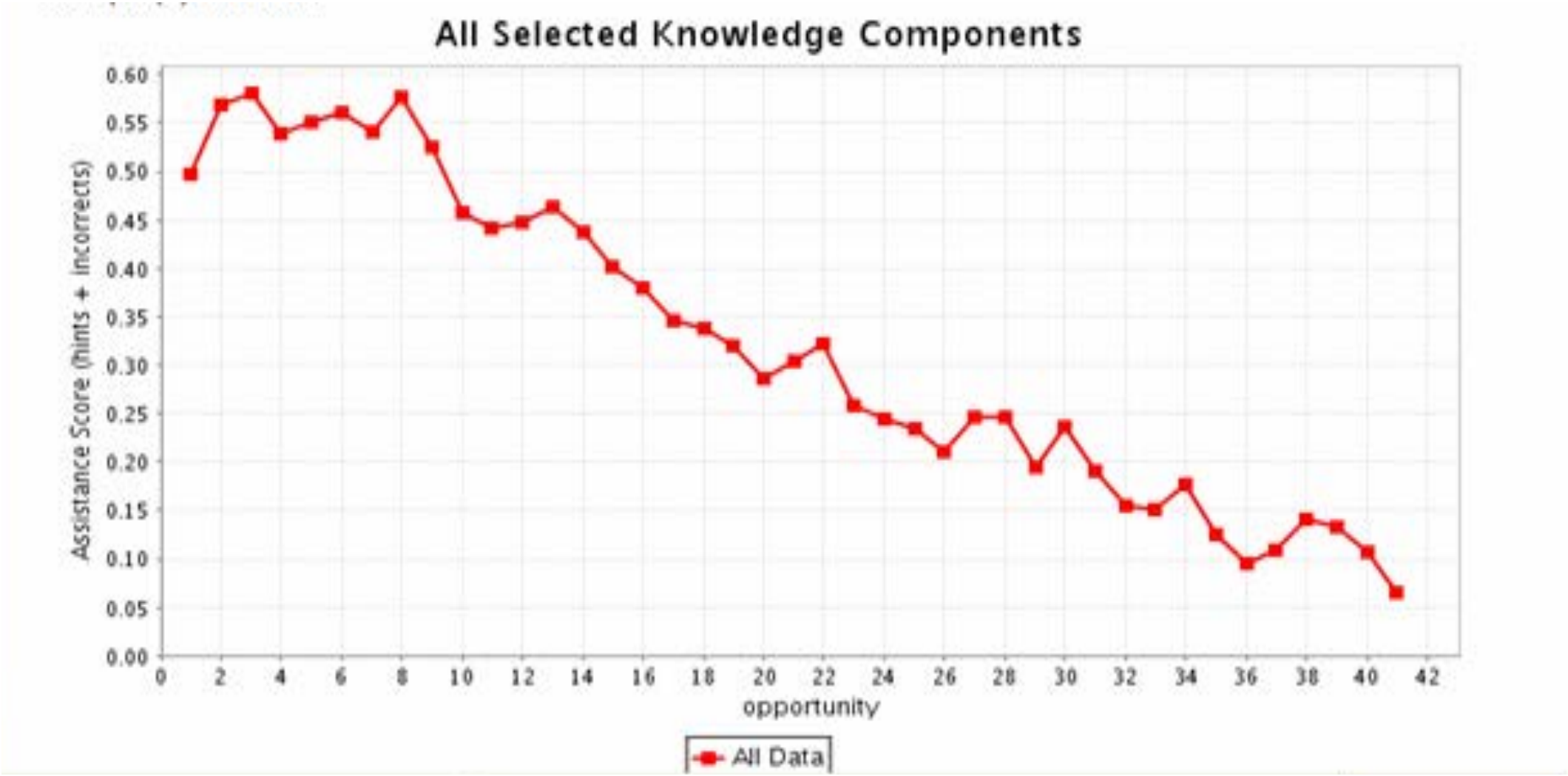
Data and Analytics

Types of Data	Types of Analytics
Structural	Design Audit
Use and Assessment	RISE
Learner Interaction	Model Validation & Improvement

Model: Learning Curve Analysis



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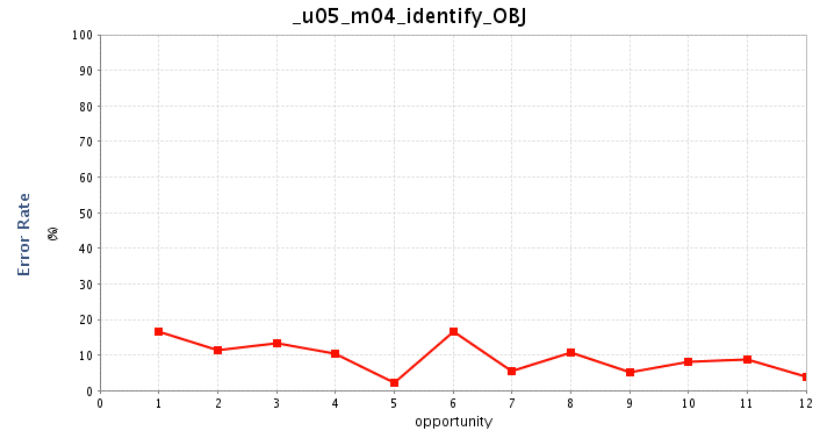
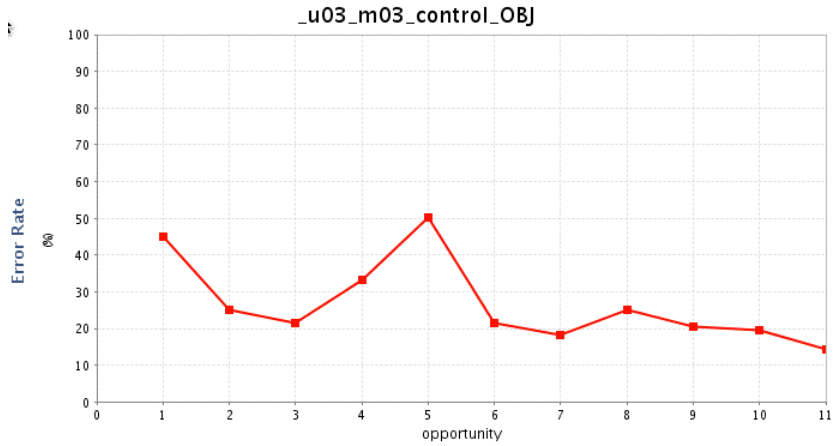
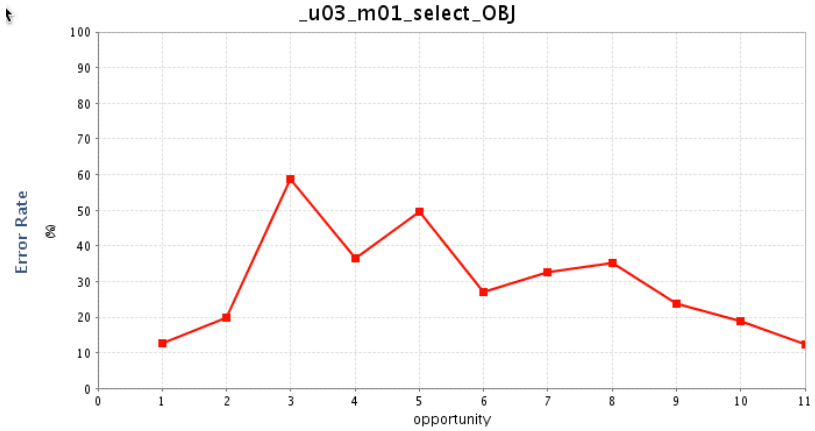
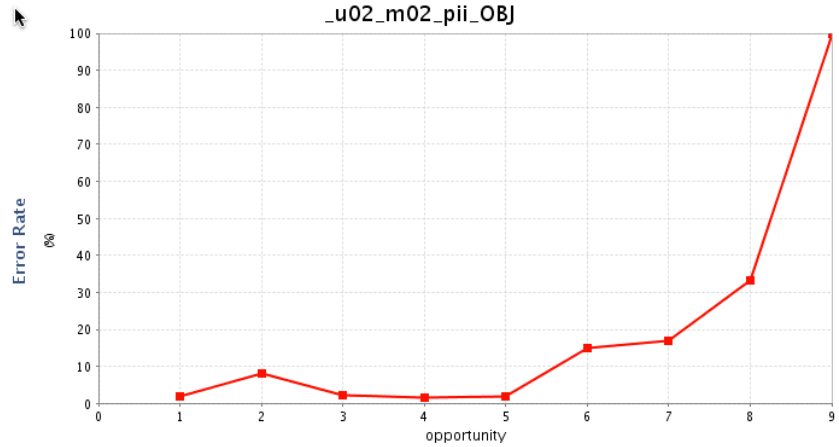
Other Learning Curves









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Model: Does practice support assessment?

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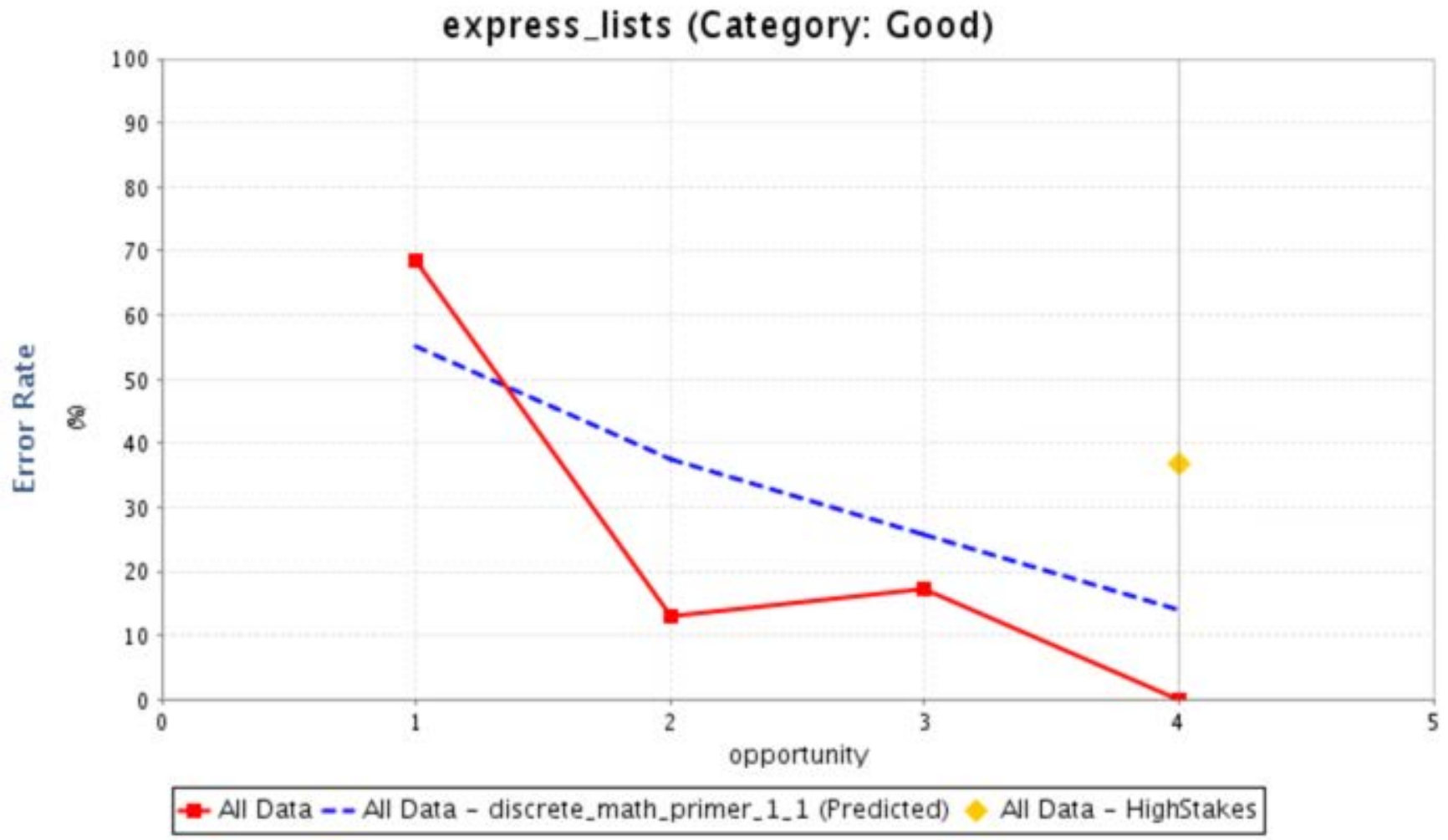
Discontinuity Analysis



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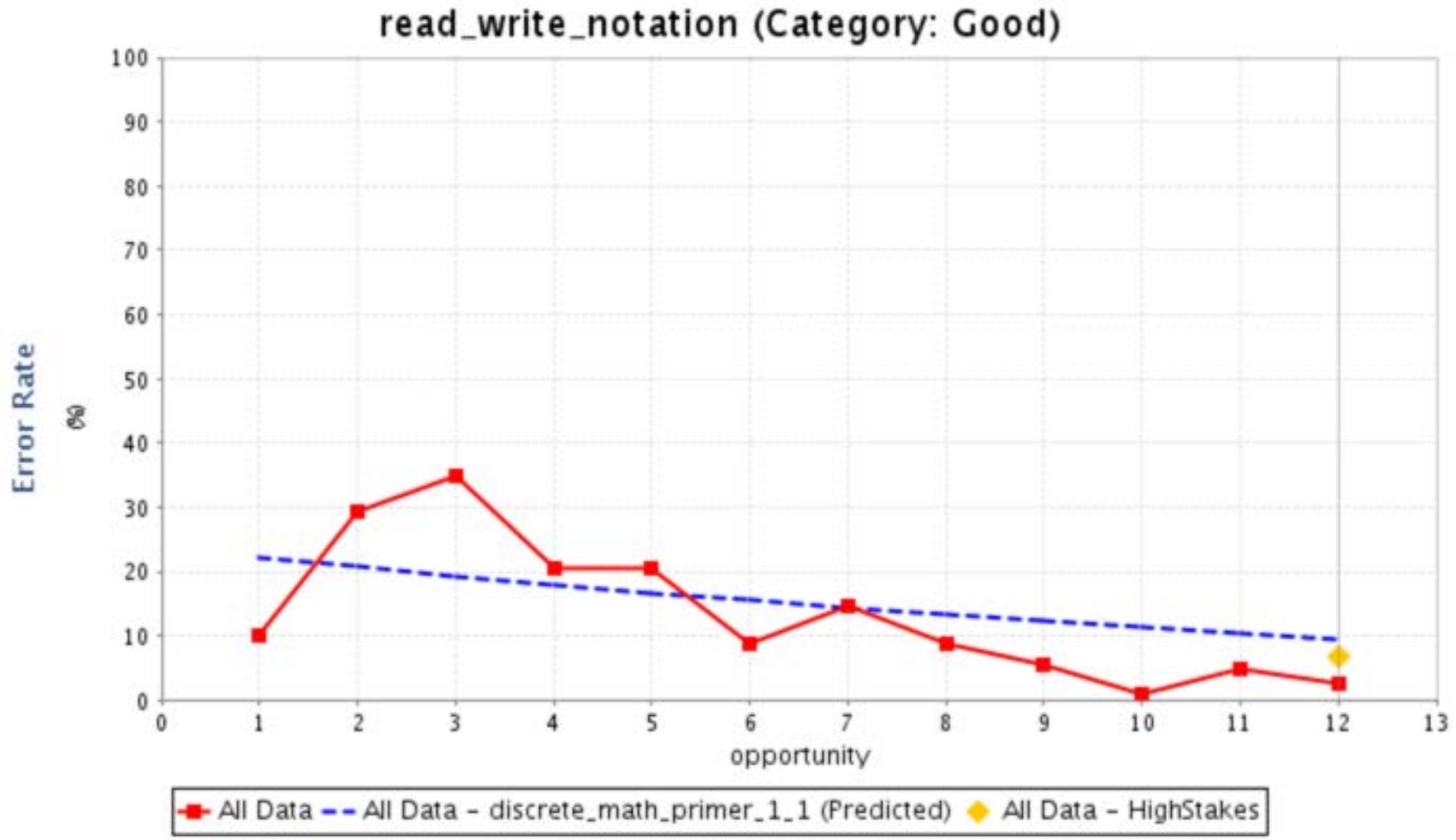
Discontinuity Analysis



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Data and Analytics

Types of Data	Types of Analytics
Structural	Design Audit
Use and Assessment	RISE
Learner Interaction	Model Validation & Improvement
Performance	Activity Improvement

Activity: Where can individual activities and questions be improved?

Activity Improvement

- Overview
- Objectives
- All Resources
- Computing@Carnegie Mellon
  - Unit 4: Information Literacy
    - Module 11: Introduction to Information ...
    - Module 12: University Libraries
    - Module 13: Understanding Information
    - Module 14: Effective Searching
    - Module 15: Evaluating Sources
    - Module 16: Academic Integrity
    - Exam-Readiness Quiz: Information Liter...
  - Unit 5: Safe Computing
    - Module 17: Introduction to Safe Computi...

Skill: Use the criteria of currency, relevance, point of view and authority to evaluate sources in relation to particular research goals and objectives.

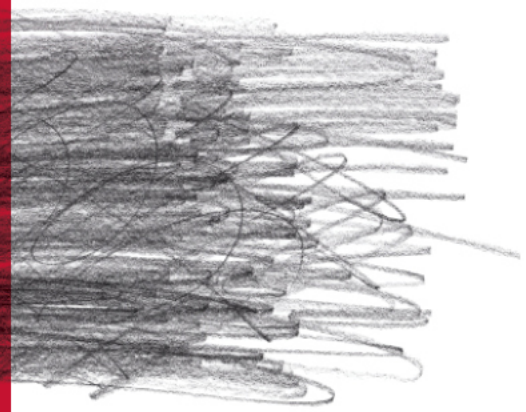
Question: Point of View (represents multiple perspectives)	1493	0.86	98%	33%
Question: Currency (publication date)	1525	1.33	99%	13%
Question: Authority (reputable author)	1510	1.03	99%	36%
Question: This article is from Time magazine, but if the informat...	1530	0.46	99%	64%
Question: Relevance (related to your task)	1502	0.44	99%	65%
Question: Because information about the author is not listed, yo...	1515	0.41	99%	61%
Question: The information would be relevant if you were at whic...	1511	1.46	99%	22%
Question: The author's purpose in this article is to:	1517	0.55	99%	66%
Question: An article written by someone who has a doctoral deg...	1494	0.17	99%	84%
Question: Point of View (represents multiple perspectives)	1471	0.84	99%	33%
Question: The author's purpose in this article is to:	1509	0.54	99%	64%
Question: Authority (the author is reputable)	1467	1.21	99%	13%
Question: Relevance (related to your task)	1462	0.51	99%	57%
Question: Currency (publication date)	1549	0.67	99%	57%
Question: A lack of publication date in this article is irrelevant be...	1569	0.30	99%	72%
Question: The information would be relevant if you were at whic...	1487	1.28	99%	31%

LEARNING ENGINEERING COMMUNITY

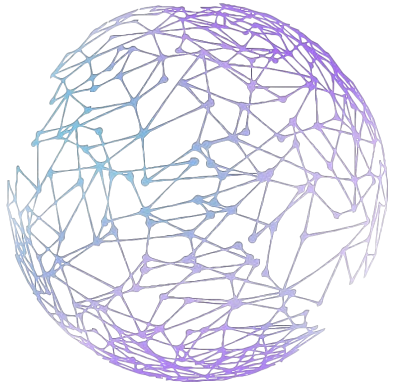
COMMUNITY

Carnegie Mellon University

HERBERT SIMON



In Progress



LearnSphere

SAIL Platform

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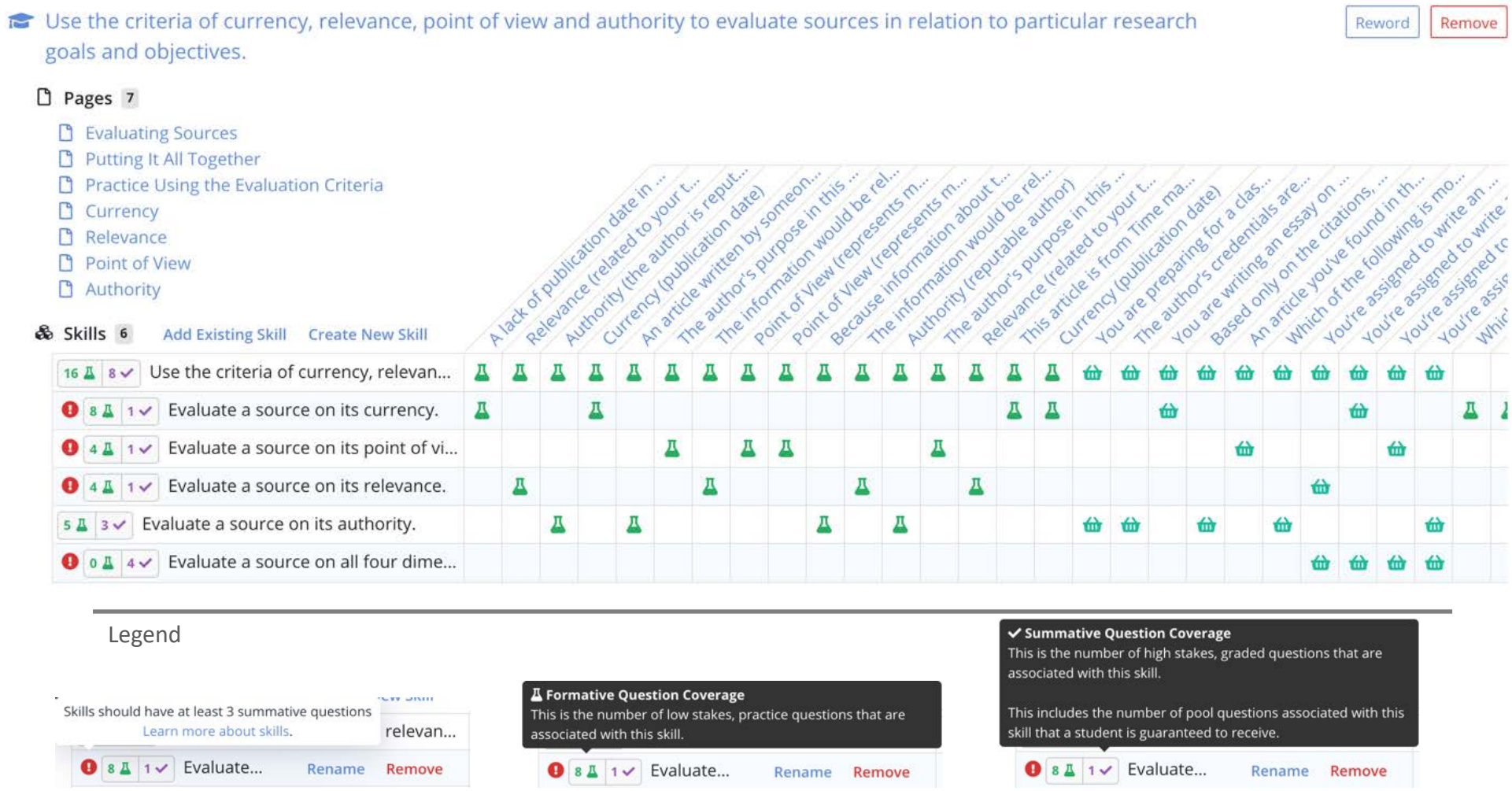
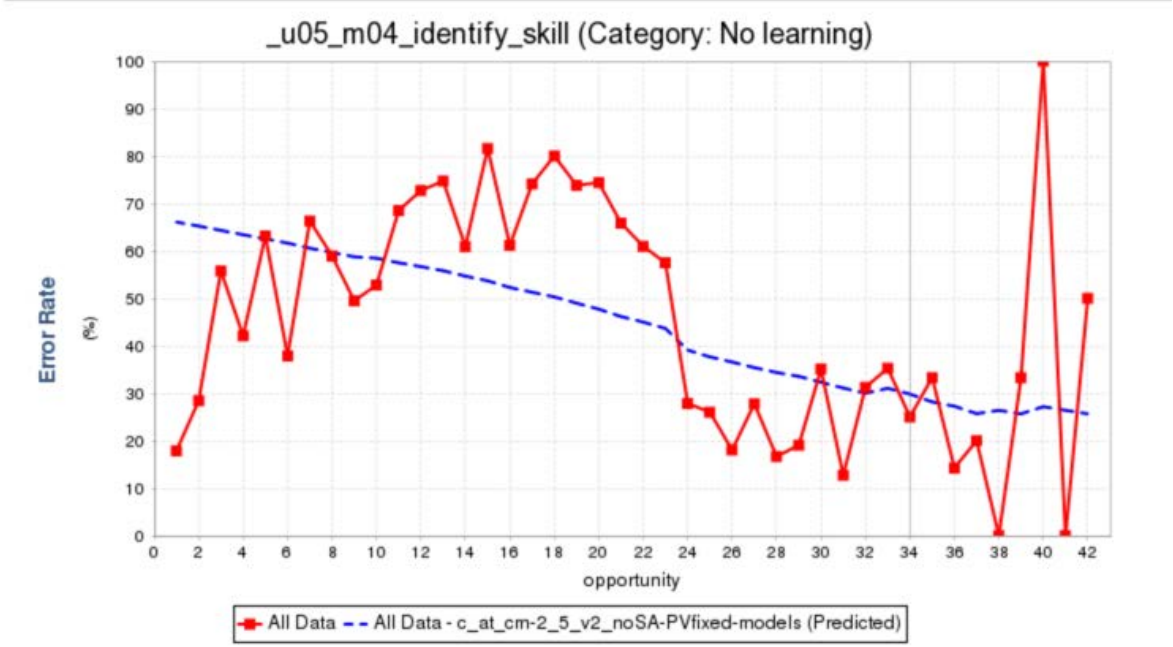
Handouts

Carnegie Mellon University
The Simon Initiative

Design Audit



Model Analytics: Learning Curve



hide graph info

Min and max opportunity cutoffs: -
Last opportunity categorized: **34**

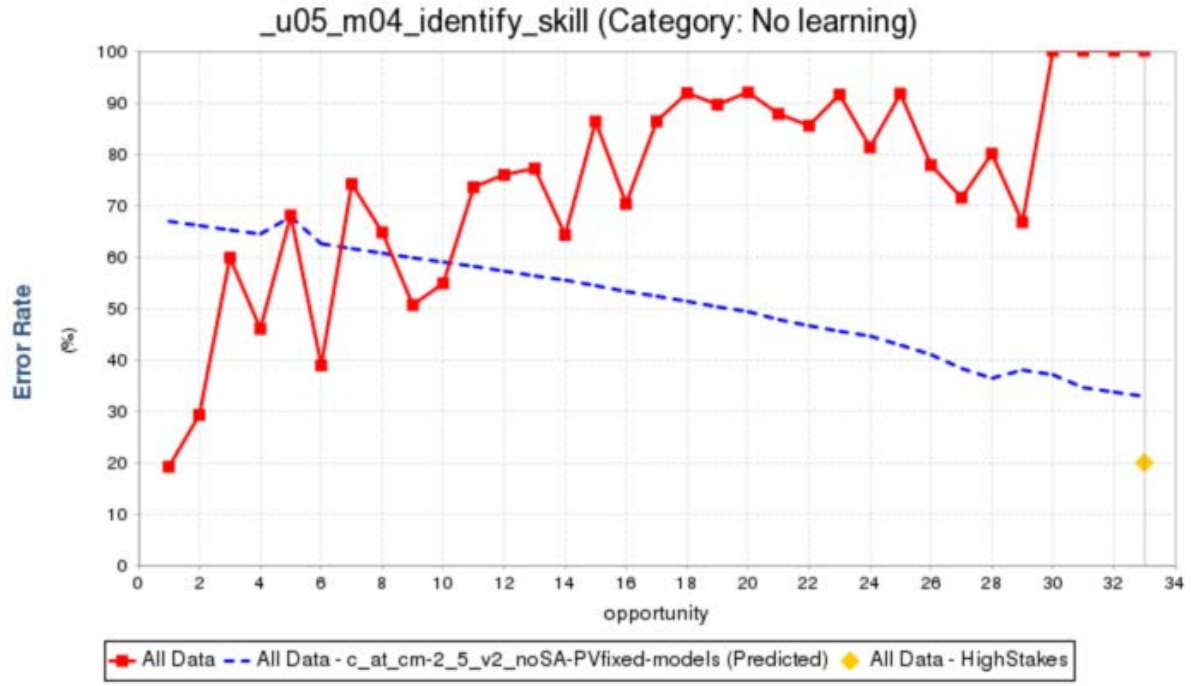
Included observations (dropped observations)
All Data: **2,694 (0)**

show point info
hide observation table

All Data

Opportunity Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of Observations	95	95	95	95	95	95	95	95	95	89	89	88	87	87	87	85	85	85	84	82
Opportunity Number	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Number of Observations	82	82	80	79	73	72	72	66	63	57	55	48	17	12	9	7	5	3	3	2
Opportunity Number	**41**	**42**																		
Number of Observations	2	2																		

Model Analytics: Practice vs. Assessment



hide graph info

Min and max opportunity cutoffs: -
Last opportunity categorized: **33**

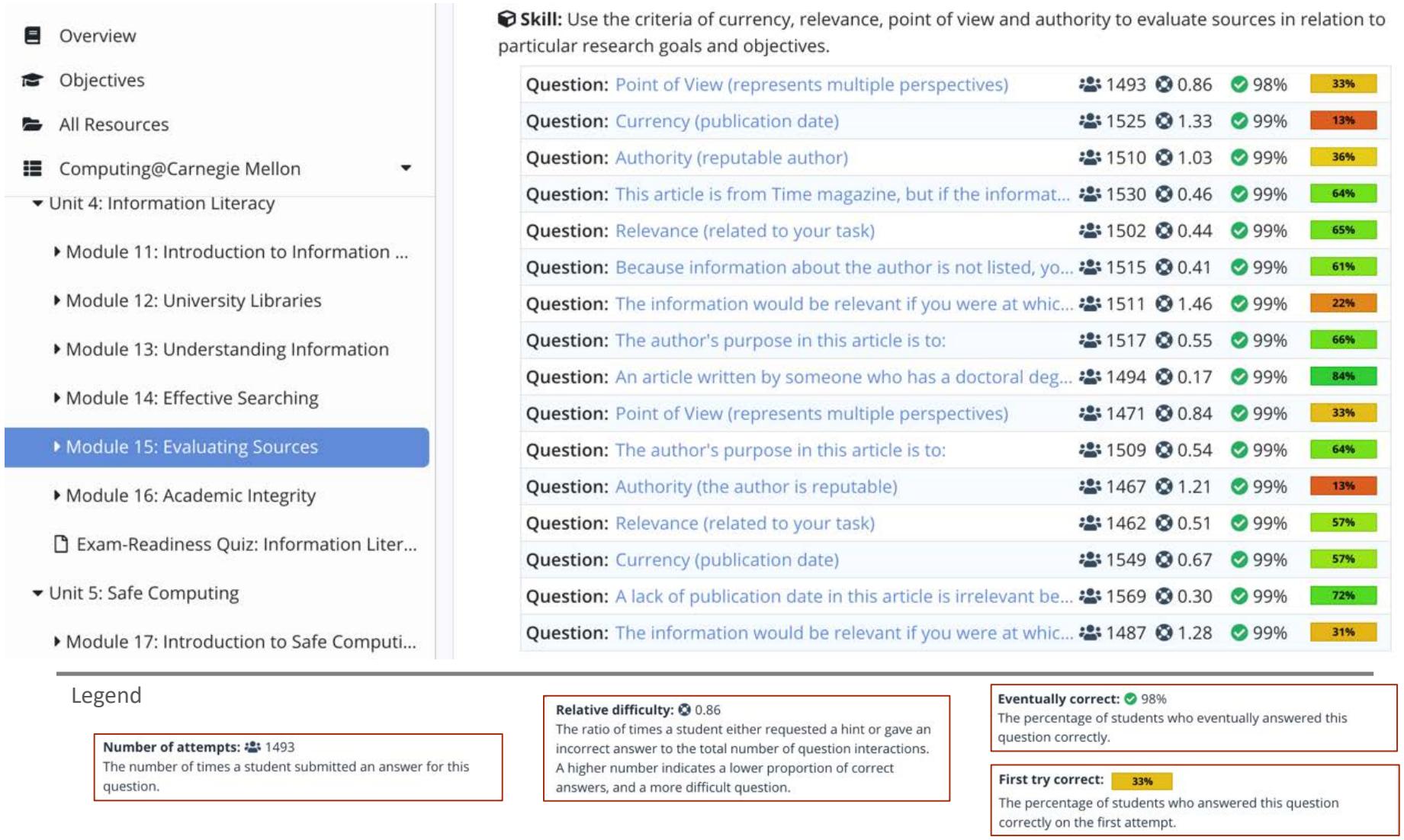
Included observations (dropped observations)
All Data: **1,780 (0)**

show point info
hide observation table

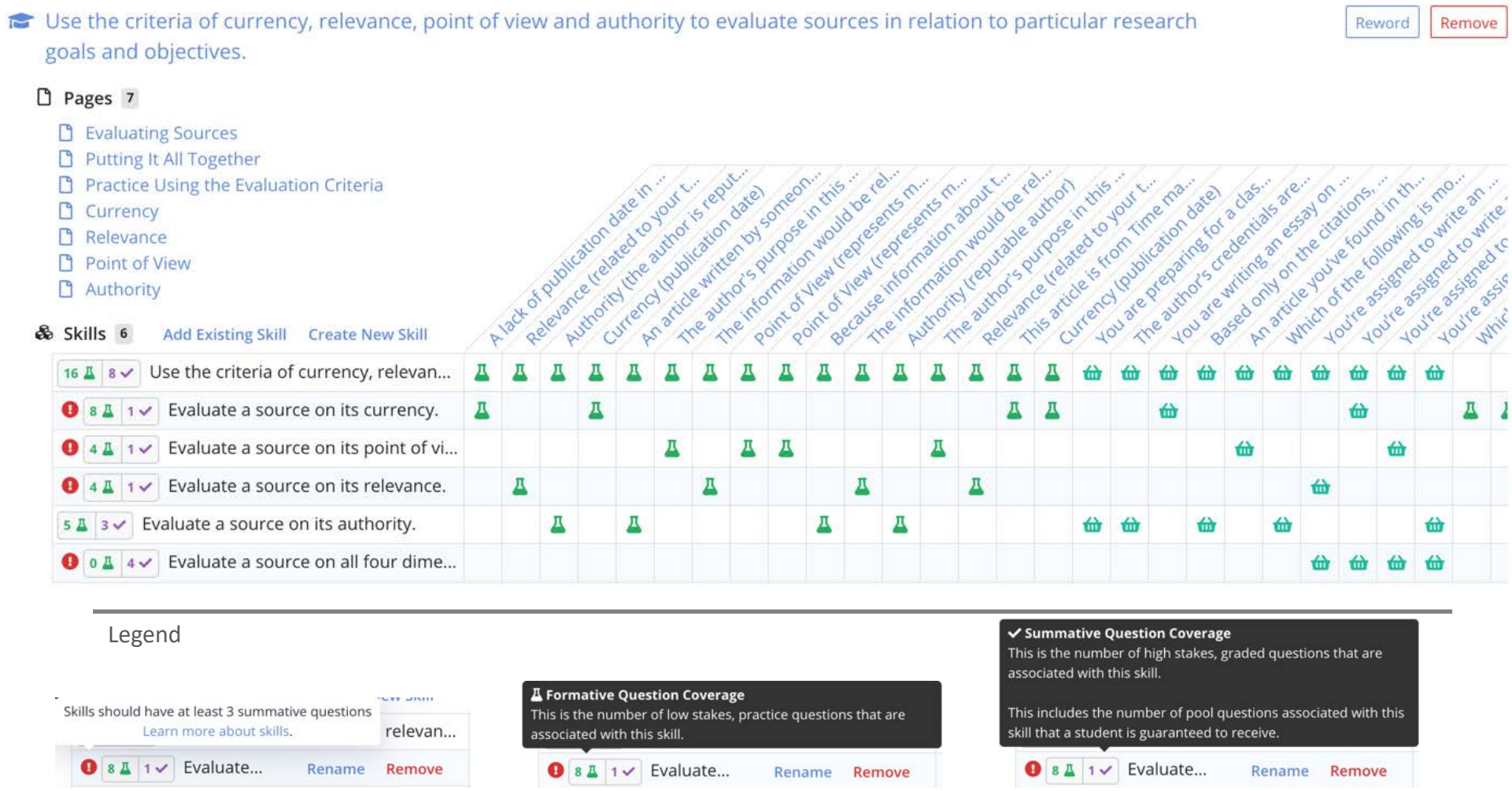
All Data

Opportunity Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of Observations	89	89	87	87	25	85	85	85	85	84	83	83	83	81	80	74	73	73	67	62
Opportunity Number	21	22	23	24	25	26	27	28	29	30	31	32	33							
Number of Observations	57	55	47	16	12	9	7	5	3	3	2	2	2							

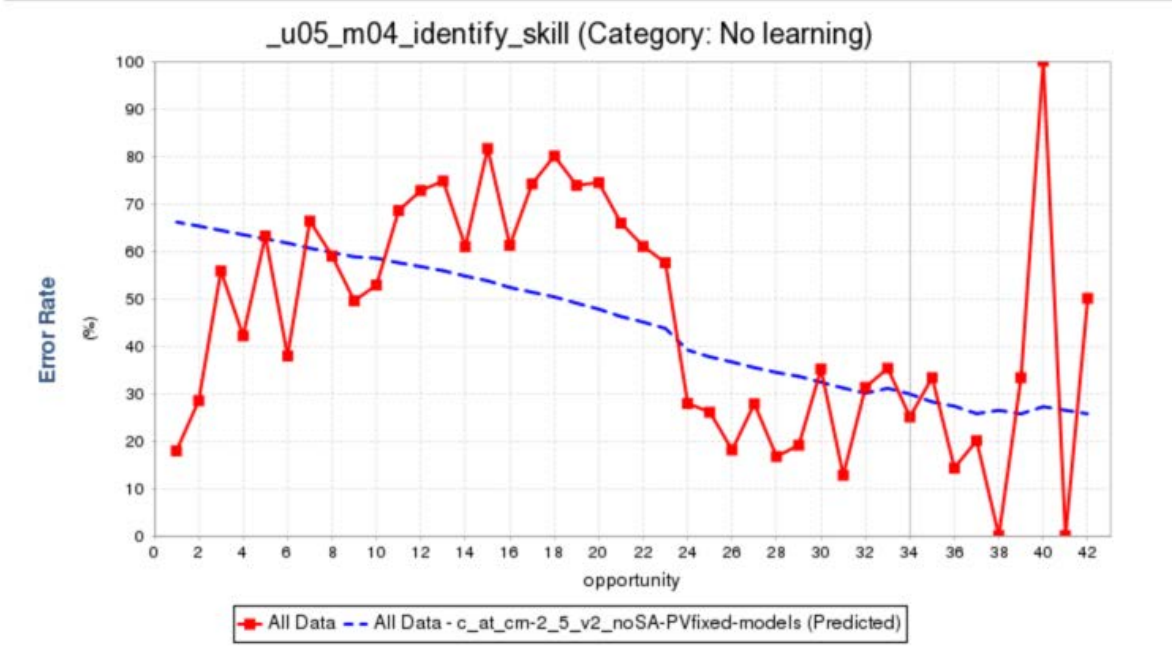
Activity Analytics



Design Audit



Model Analytics: Learning Curve



hide graph info

Min and max opportunity cutoffs: -
Last opportunity categorized: **34**

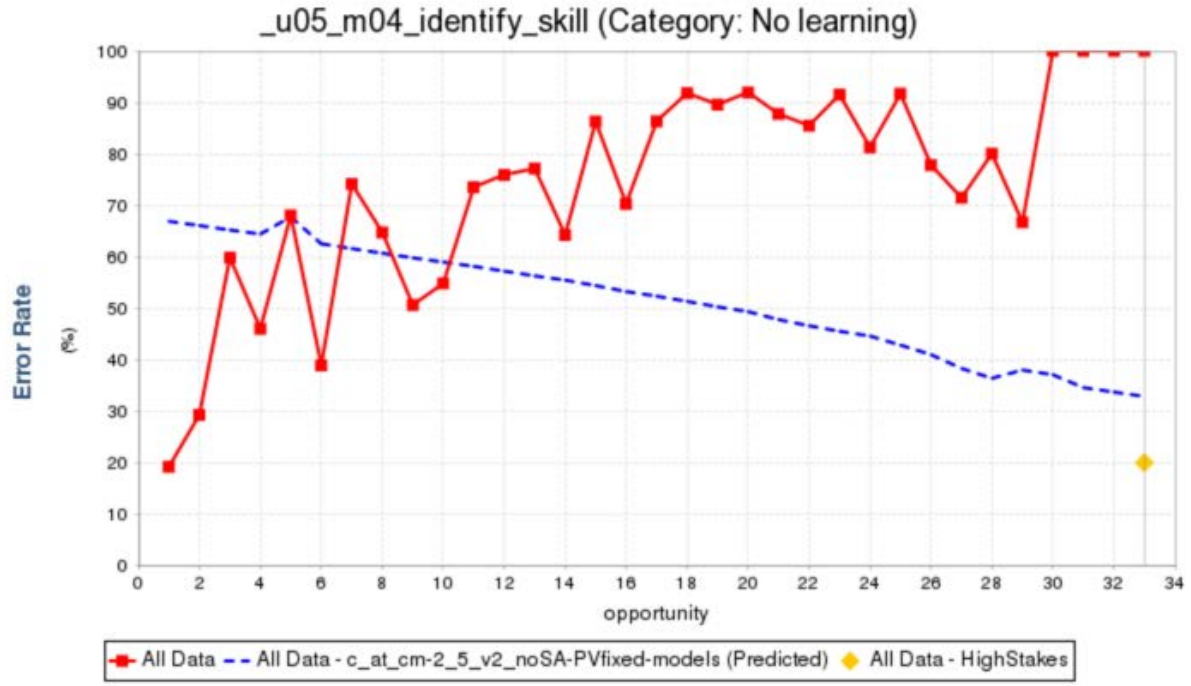
Included observations (dropped observations)
All Data: **2,694 (0)**

show point info
hide observation table

All Data

Opportunity Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of Observations	95	95	95	95	95	95	95	95	95	89	89	88	87	87	87	85	85	85	84	82
Opportunity Number	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Number of Observations	82	82	80	79	73	72	72	66	63	57	55	48	17	12	9	7	5	3	3	2
Opportunity Number	**41**	**42**																		
Number of Observations	2	2																		

Model Analytics: Practice vs. Assessment



hide graph info

Min and max opportunity cutoffs: -
Last opportunity categorized: **33**

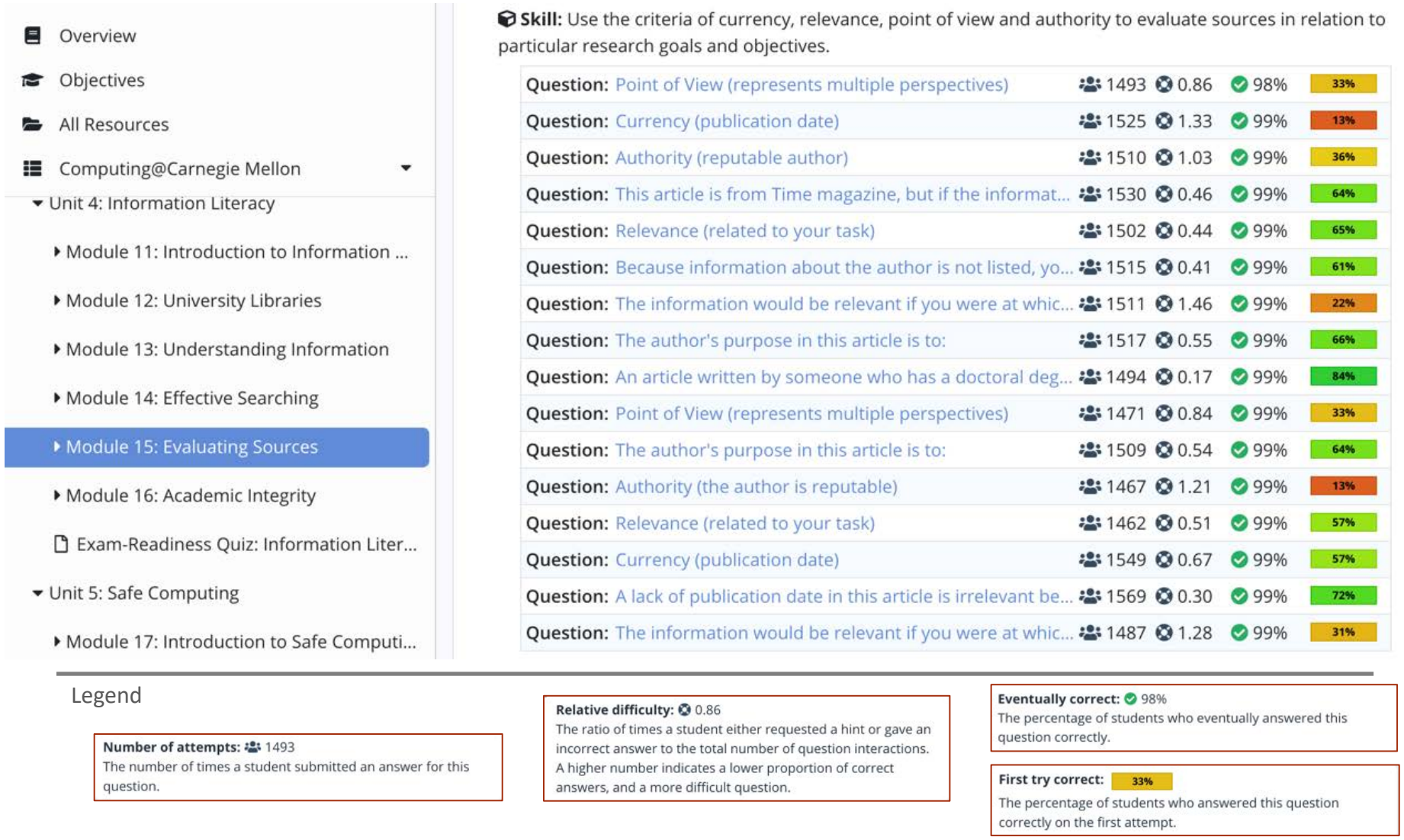
Included observations (dropped observations)
All Data: **1,780 (0)**

show point info
hide observation table

All Data

Opportunity Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of Observations	89	89	87	87	25	85	85	85	85	84	83	83	83	81	80	74	73	73	67	62
Opportunity Number	21	22	23	24	25	26	27	28	29	30	31	32	33							
Number of Observations	57	55	47	16	12	9	7	5	3	3	2	2	2							

Activity Analytics



Extra

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Statistics

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Module 2

Examining Relationships

PREDICTED MASTERY LEVELS

Learning Objectives

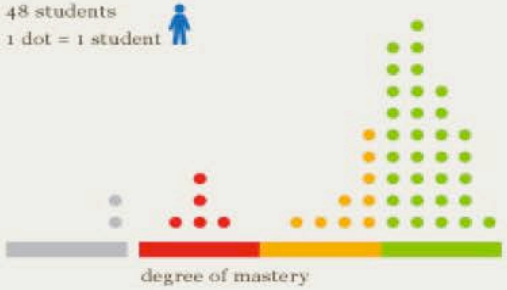
Classify a data analysis situation (involving two variables) according to the "role type classification," and state the appropriate display and/or numerical measures that should be used in order to summarize the data. [Show Sub-Learning Objectives]

PREDICTED MASTERY LEVELS

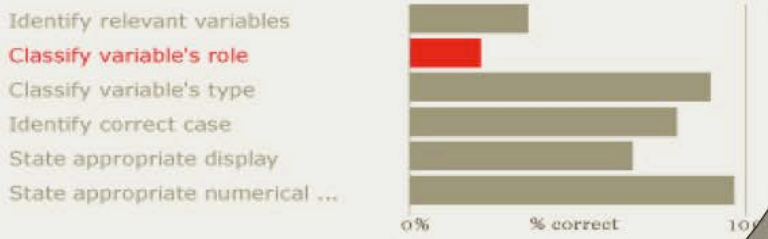
Classify a data analysis situation (involving two variables) according to the "role type classification," and state the appropriate display and/or numerical measures that should be used in order to summarize the data. [Hide Sub-Learning Objectives]

Predicted Mastery *by Student*

48 students
1 dot = 1 student



Class Accuracy *by Sub-Learning Objective*

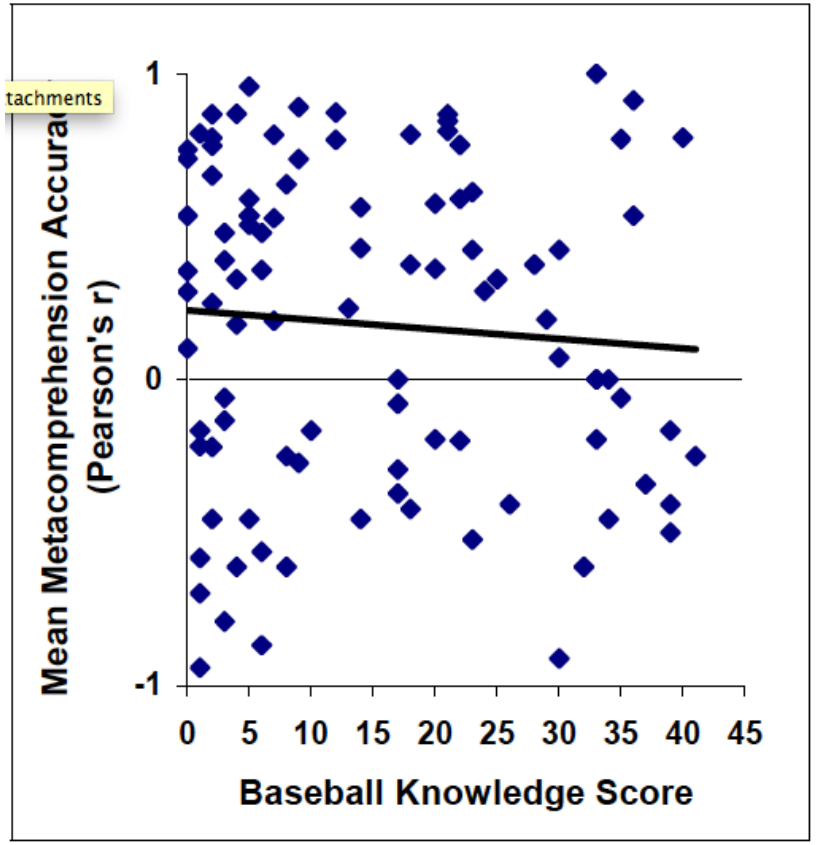


Produce a two-way table, and interpret the information stored in it about the association between two cat. variables by comparing conditional percents. [Show Sub

Module-Level Reports

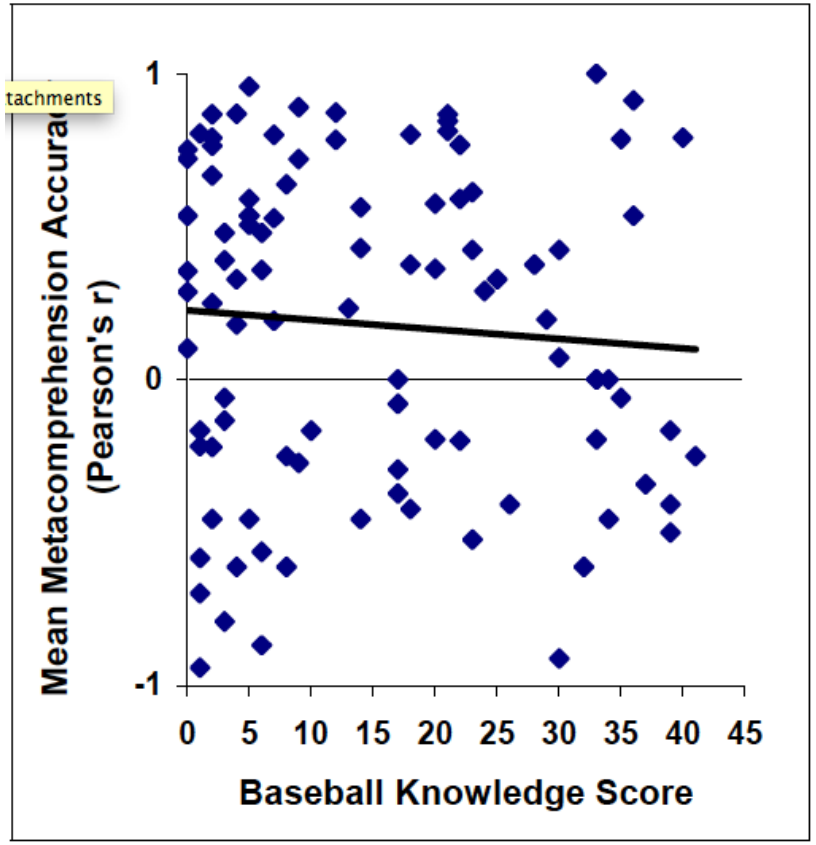
Do we know when we are learning?

- Students are poor at judging what they learned



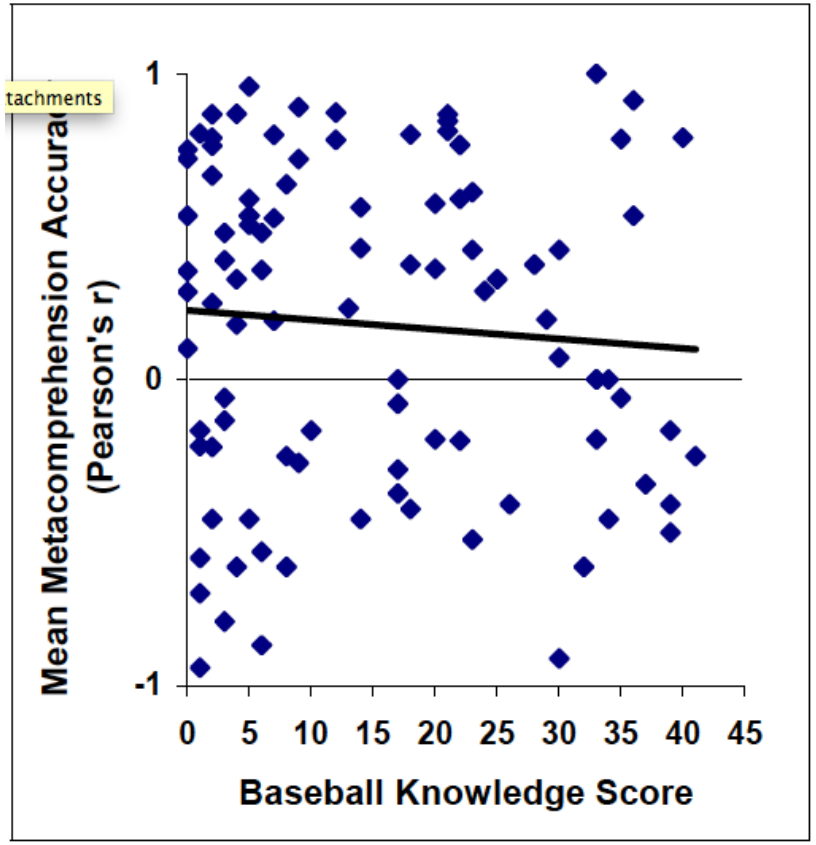
Do we know when we are learning?

- Students are poor at judging what they learned
- Liking is not learning



Do we know when we are learning?

- Students are poor at judging what they learned
- Liking is not learning
- Why? Students have insufficient mental resources to learn and monitor their own learning



Do we know when we are learning?

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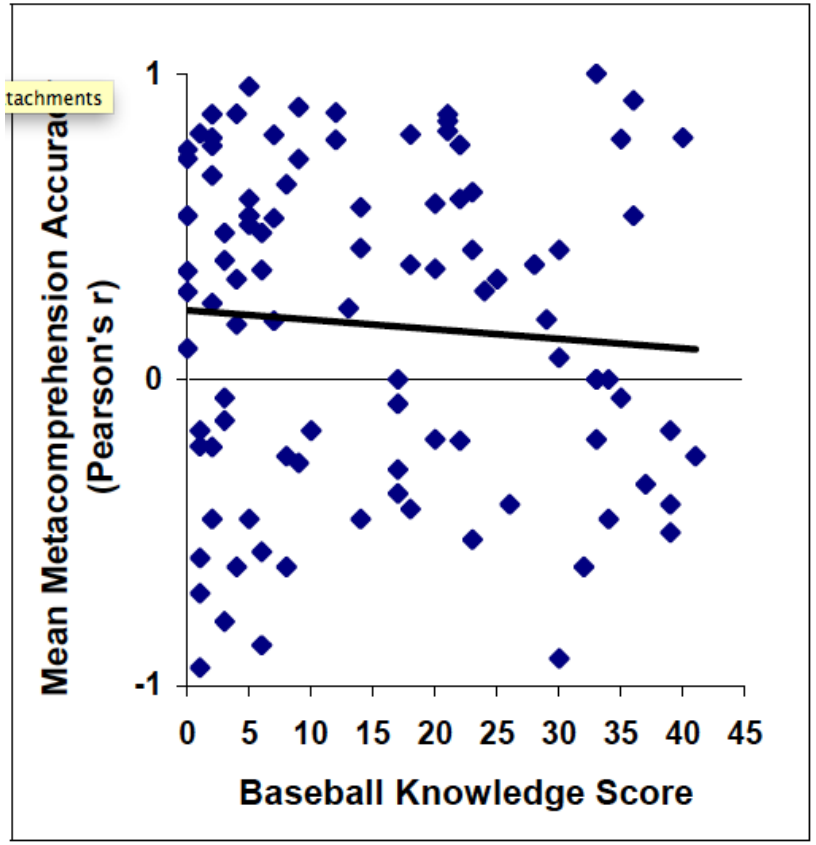
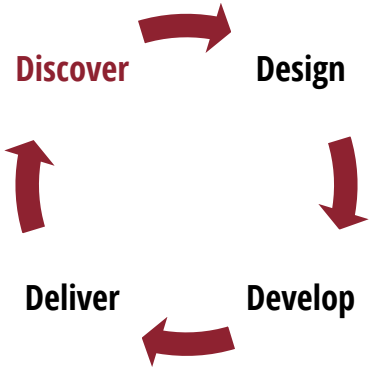


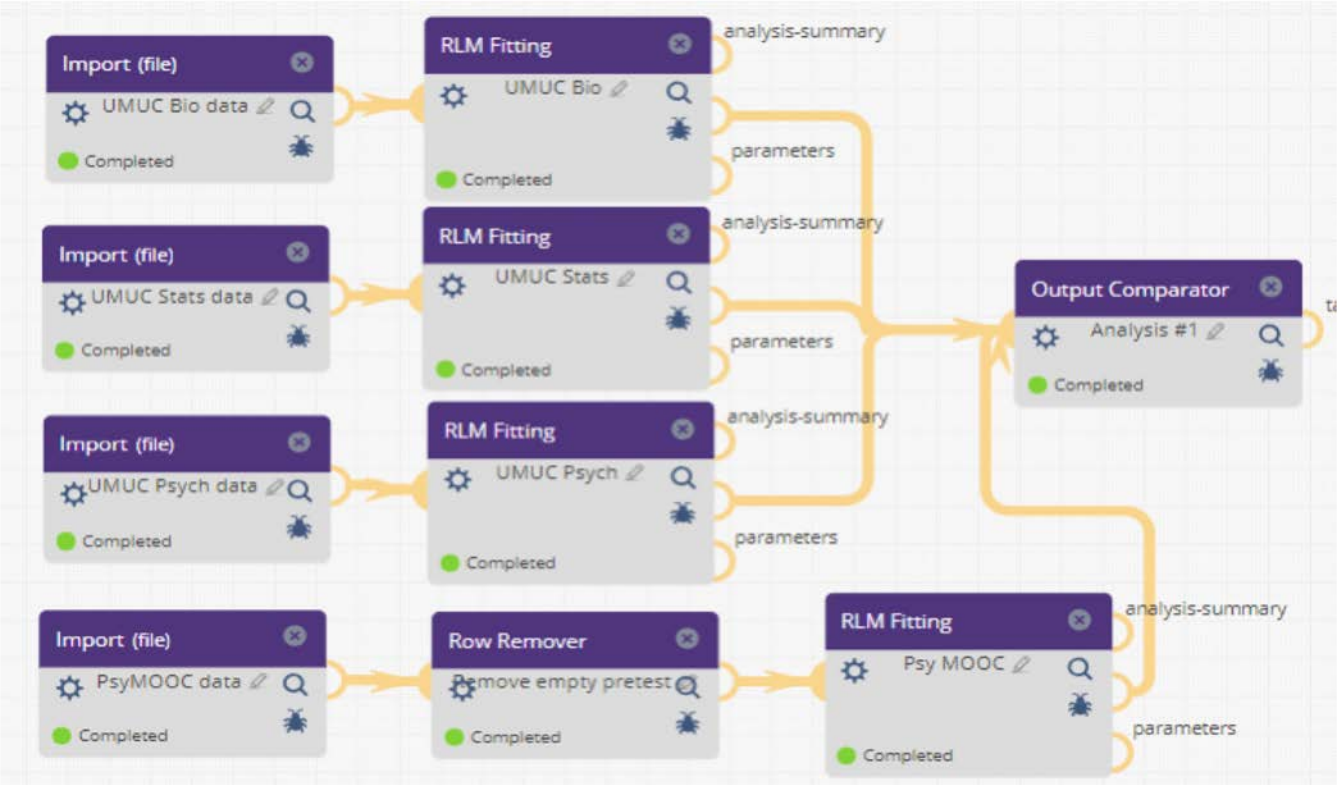
We experience *illusions of knowing and learning*

Why?

Learning is mostly outside our conscious awareness

Discovery: Does doer effect apply across courses?





Which learning resources are making the most difference in your courses?

Try this workflow on your data at [LearnSphere.org!](LearnSphere.org)

Koedinger et al. (2016). Is the Doer Effect a Casual Relationship? How Can We Tell and Why It's Important.

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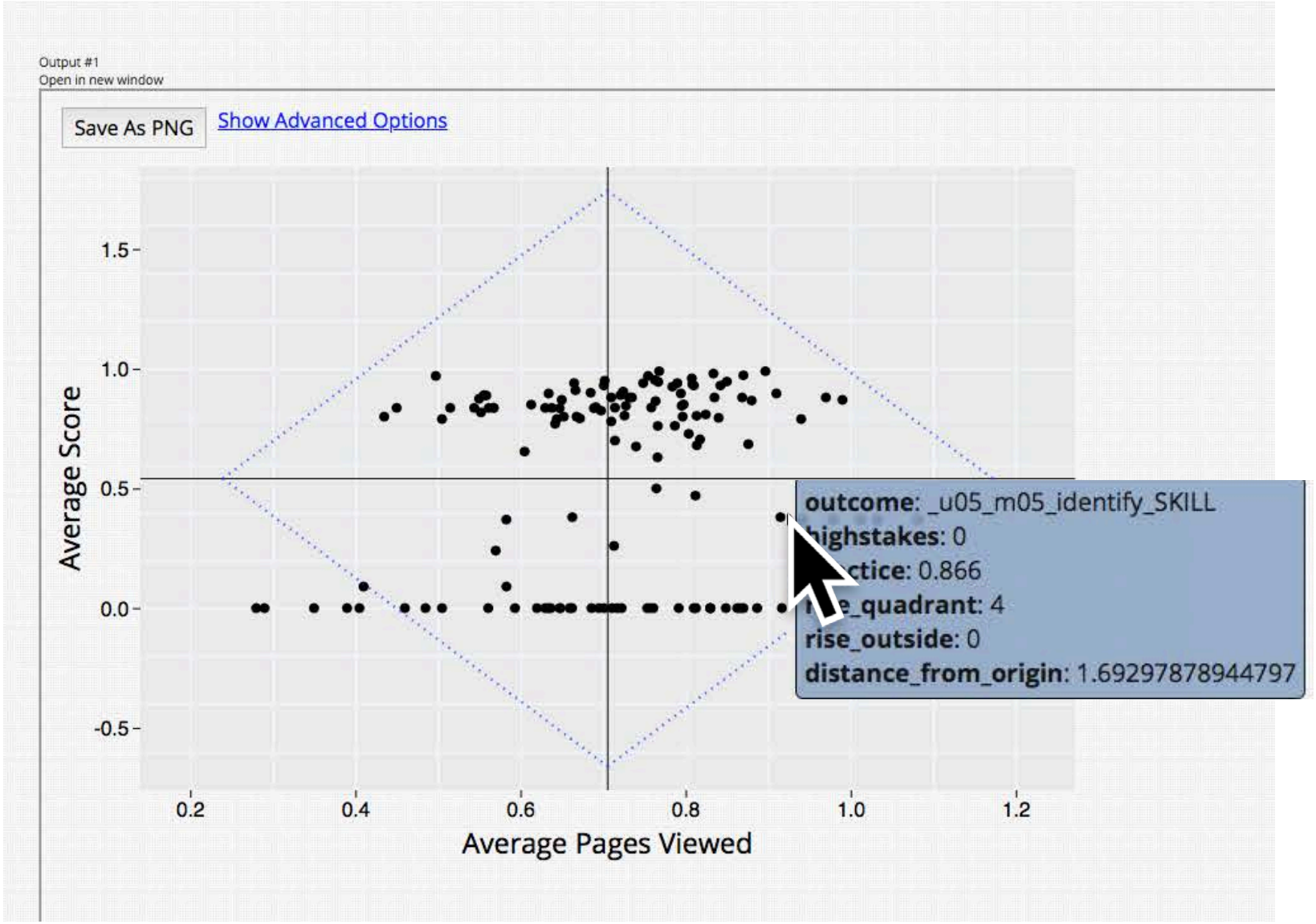
A - RISE


Output #1
Open in new window
Save As PNG
Show Advanced Options
1.5
1.0
0.5
0.0
-0.5
Average Score
0.2
0.4
0.6
0.8
1.0
1.2
Average Pages Viewed
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highstakes: 0
ctice: 0.866
e_quadrant: 4
rise_outside: 0
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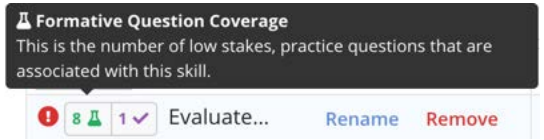
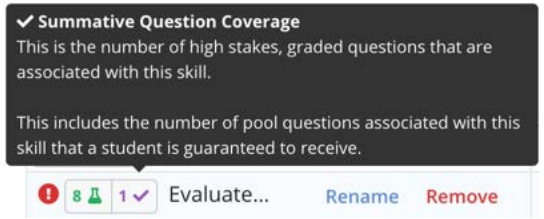
A - Design Audit

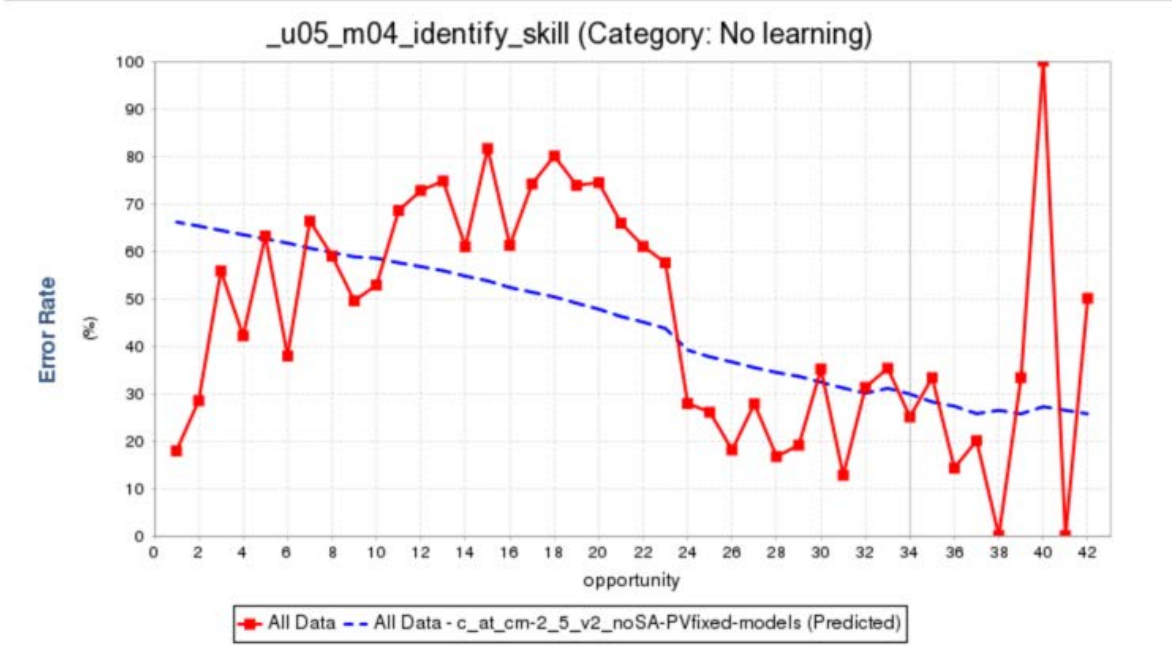
Skill: Use the criteria of currency, relevance, point of view and authority to evaluate sources in relation to particular research goals and objectives.

Legend





A - Model Analytics: Learning Curve



hide graph info

Min and max opportunity cutoffs: -
Last opportunity categorized: **34**

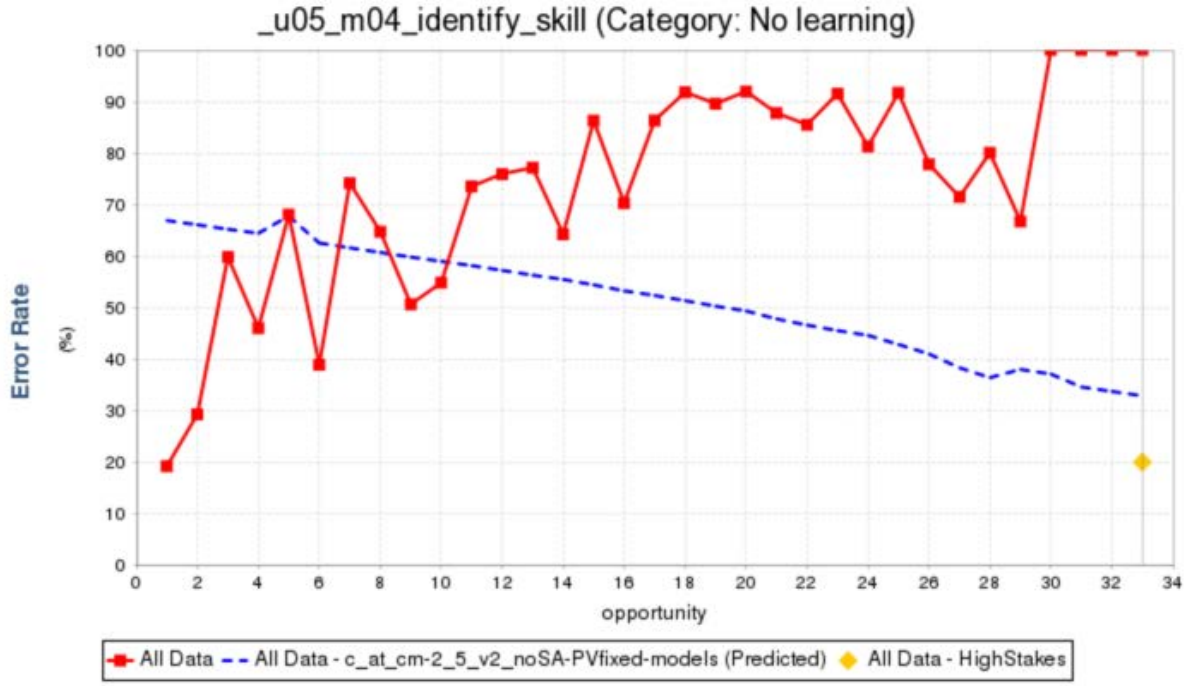
Included observations (dropped observations)
All Data: **2,694 (0)**

show point info
hide observation table

All Data

Opportunity Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of Observations	95	95	95	95	95	95	95	95	95	89	89	88	87	87	87	85	85	85	84	82
Opportunity Number	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Number of Observations	82	82	80	79	73	72	72	66	63	57	55	48	17	12	9	7	5	3	3	2
Opportunity Number	**41**	**42**																		
Number of Observations	2	2																		

A - Model Analytics: Practice vs. Assessment



hide graph info

Min and max opportunity cutoffs: -
Last opportunity categorized: **33**

Included observations (dropped observations)
All Data: **1,780 (0)**

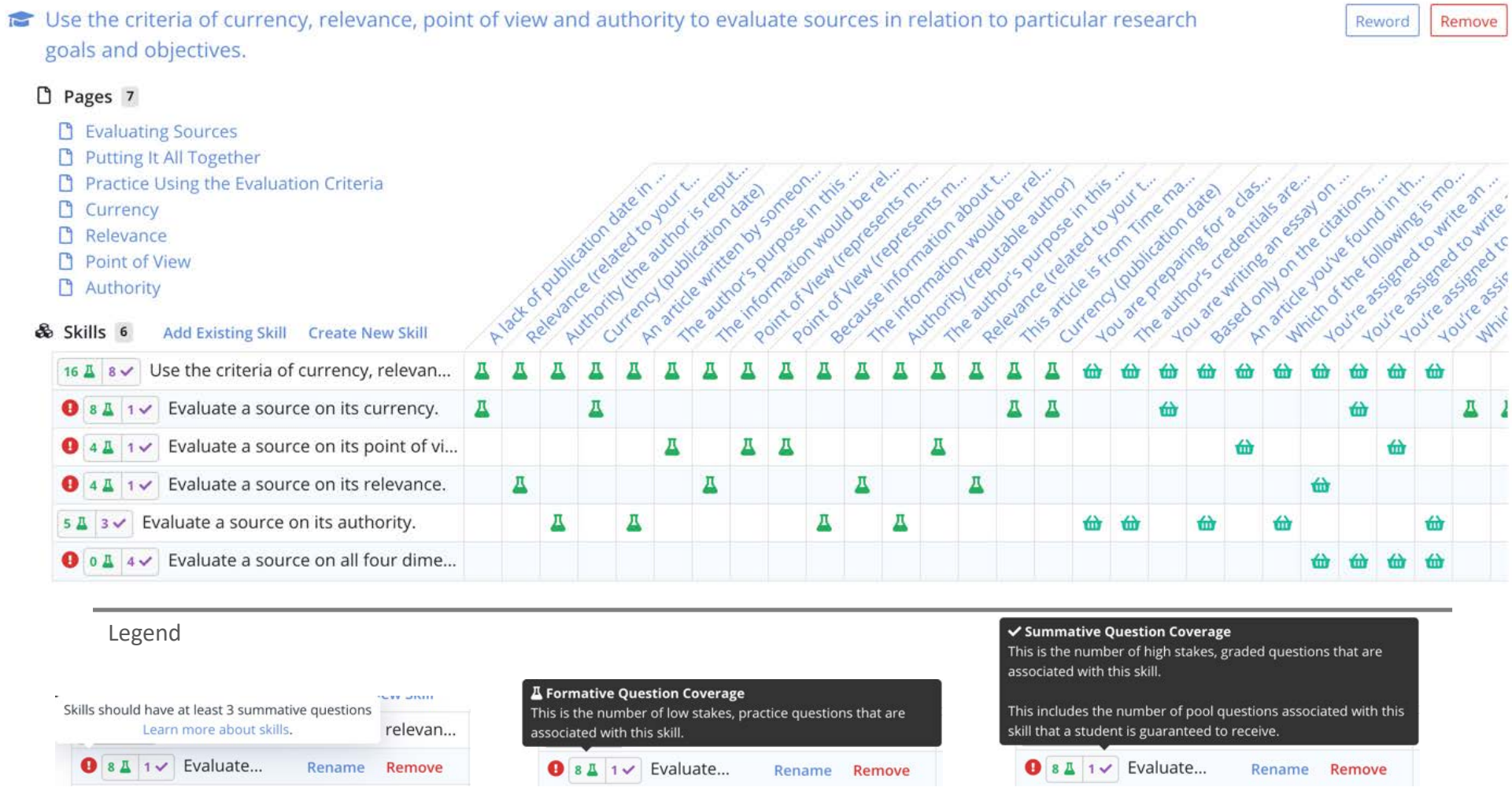
show point info
hide observation table

All Data

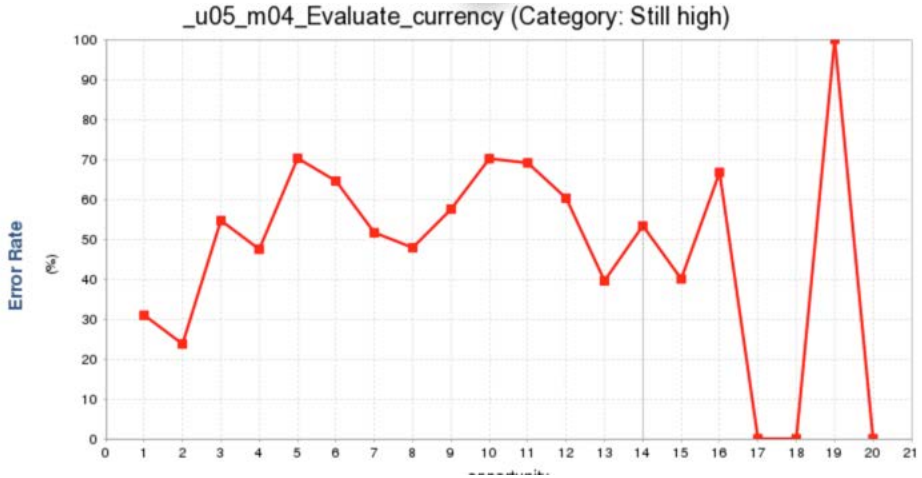
Opportunity Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of Observations	89	89	87	87	25	85	85	85	85	84	83	83	83	81	80	74	73	73	67	62
Opportunity Number	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**							
Number of Observations	57	55	47	16	12	9	7	5	3	3	2	2	2							

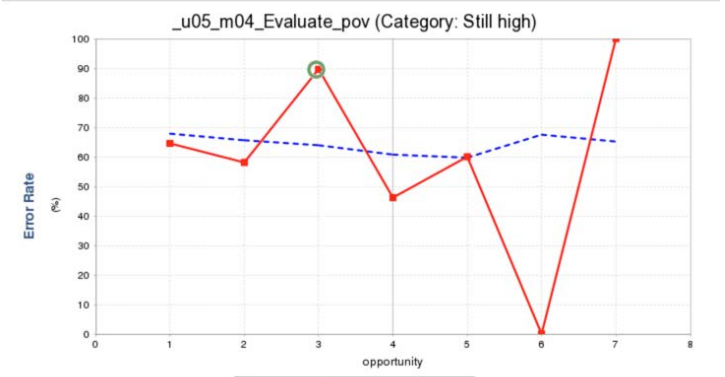
B - Design Audit

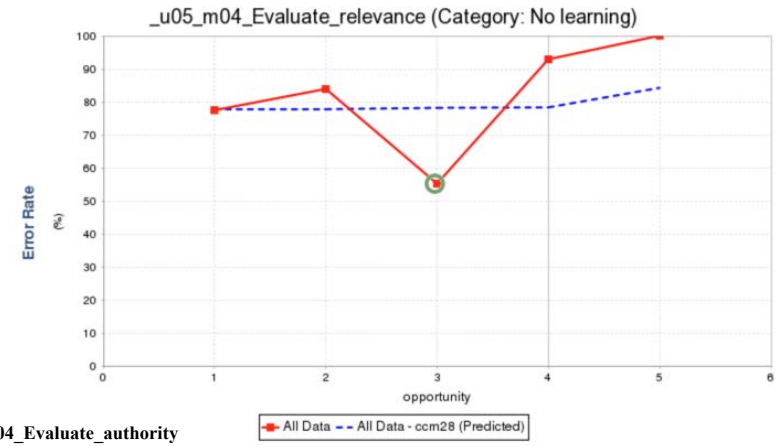
_u05_m04_Evaluate_currency	Evaluate a source on its currency.
_u05_m04_Evaluate_pov	Evaluate a source on its point of view.
_u05_m04_Evaluate_relevance	Evaluate a source on its relevance.
_u05_m04_Evaluate_authority	Evaluate a source on its authority
_u05_m04_Evaluate_Comprehensive	Evaluate a source on all four dimensions.

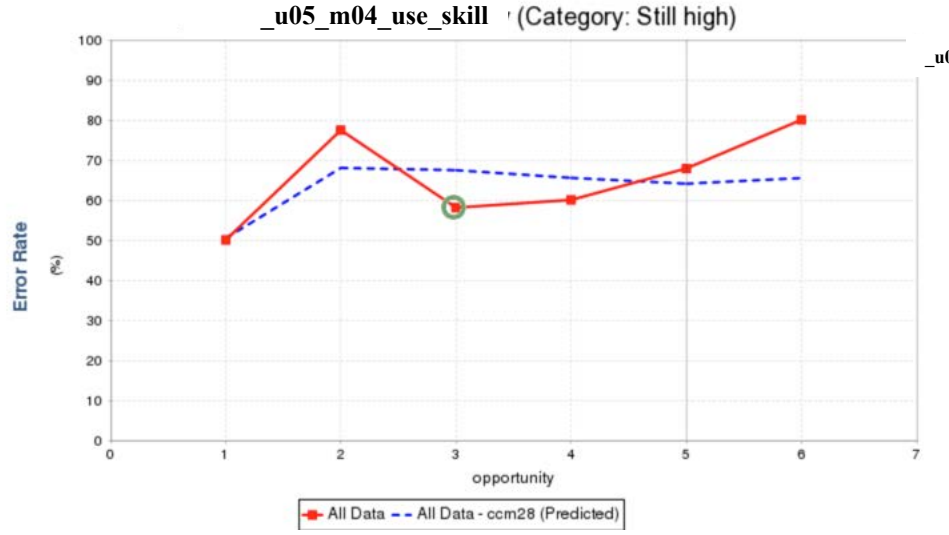


B - Learning Curves

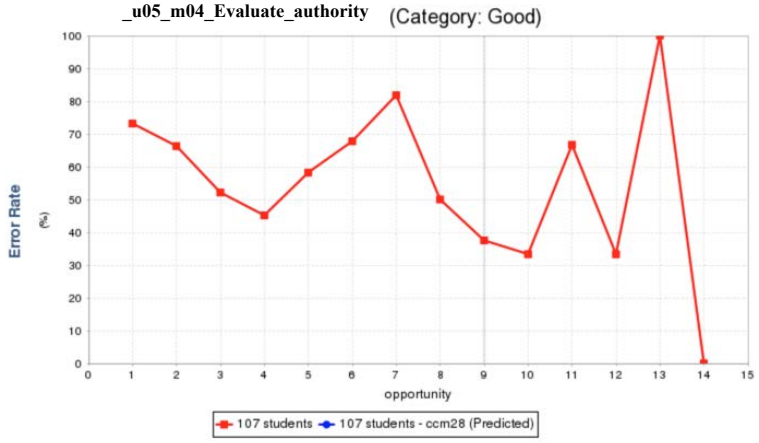


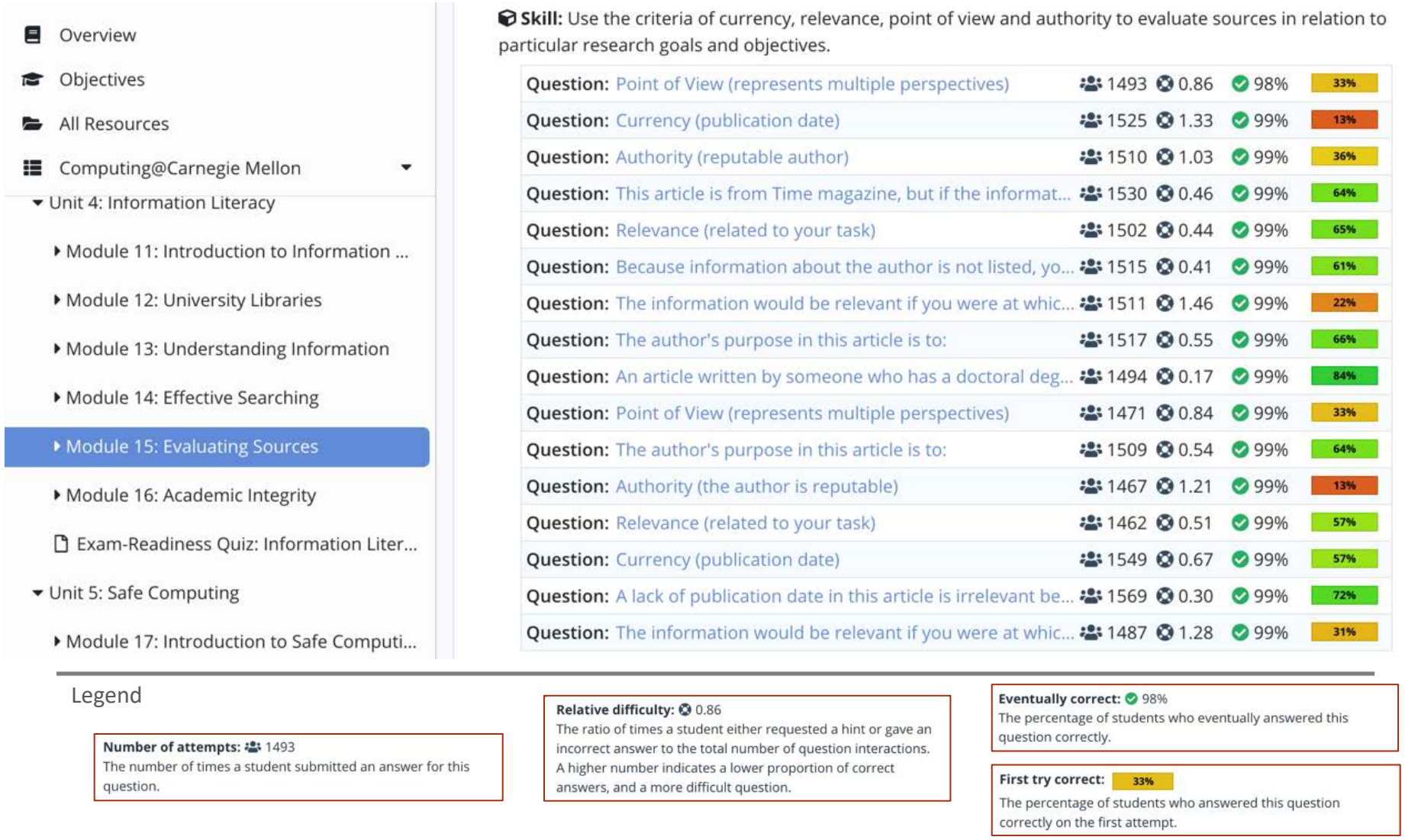






_u05_m04_Evaluate_authority



B – Practice vs. Assessment

B - Activity Analytics